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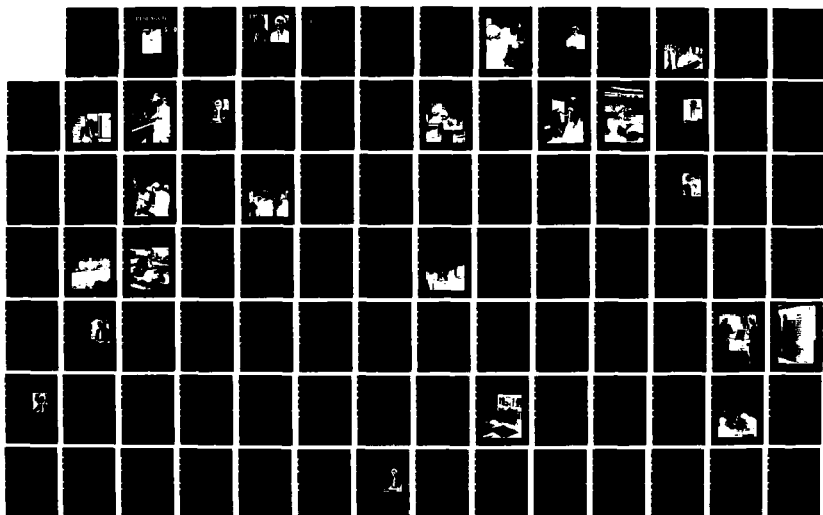
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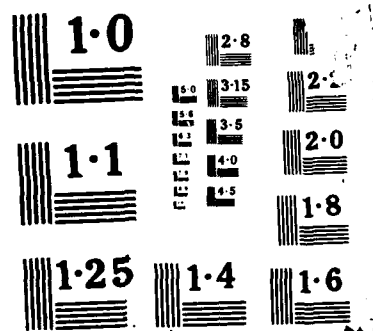
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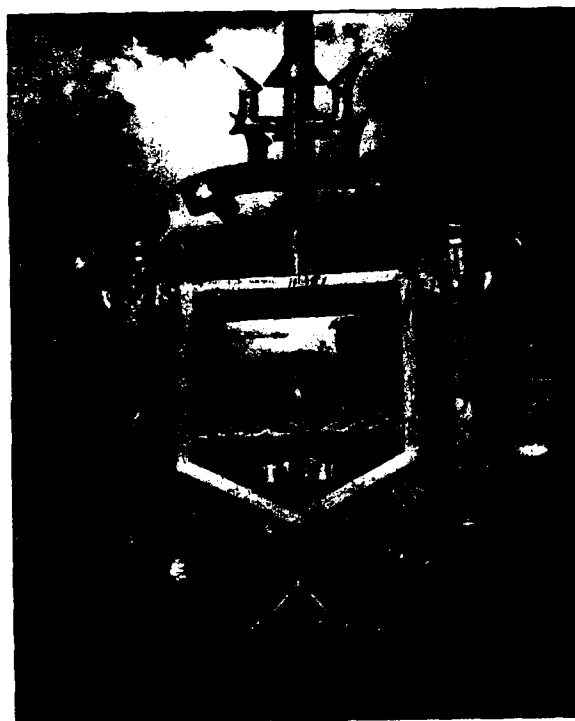
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SUMMARY OF RESEARCH

ACADEMIC DEPARTMENTS

1986-1987



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SUMMARY OF RESEARCH

1986-1987

COMPILED AND EDITED

BY

PROFESSOR FRED M. FETROW

ENGLISH DEPARTMENT

OCTOBER 1987

UNITED STATES NAVAL ACADEMY

ANNAPOLIS, MARYLAND

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KARL A. LAMB
Academic Dean



CARL S. SCHNEIDER
Director of Research

Foreword

The role of research at the Naval Academy is to maintain an atmosphere of scholarly excellence in which midshipmen seek knowledge. Discipline and curiosity are both essential to a naval officer, as to any educated man or woman, and the balance of these traits determines the character of our graduates.

In the nearly two decades since the Research Office was created, progress can be measured by the growth in research budgets, papers, books, and presentations. Naval Academy faculty and midshipmen have seized the opportunities to do research provided by local and nearby facilities, research courses, sabbaticals, and travel support.

The information presented in this report describes the research projects and productivity of our faculty and midshipmen for the 1986-1987 academic year. Each of sixteen academic departments in five divisions presents the details of its efforts. The history of the budget and productivity is presented in Figures 1 and 2, showing the growth of research by our faculty.

This growth parallels the increase in civilian

faculty Ph.D.s to ninety-one percent and growth of the program of research chairs, which has recently remained steady at six. These chairs are sponsored by various Naval Systems Commands, Naval Operations and the Chief of Naval Research. Our research funding is distributed over basic research, exploratory and advanced development, as well as O&M,N funds which contributed to the recent increase in support for newer faculty, and are administered by our Naval Academy Research Council. Additional operating funds were devoted to supporting thirty-six faculty members' efforts in instructional development, largely devoted to exploiting the Zenith 248 computers newly acquired by our faculty and midshipmen. Our major reimbursable sponsor, after the Chief of Naval Research, continues to be the David W. Taylor Naval Ship Research and Development Center, whose Annapolis and Carderock Laboratories supported the work of thirty-two of our faculty for a total of \$420,000. The Naval Research Laboratory funded eighteen faculty members' research this year, under our Cooperative Program, for a total of \$182,000.

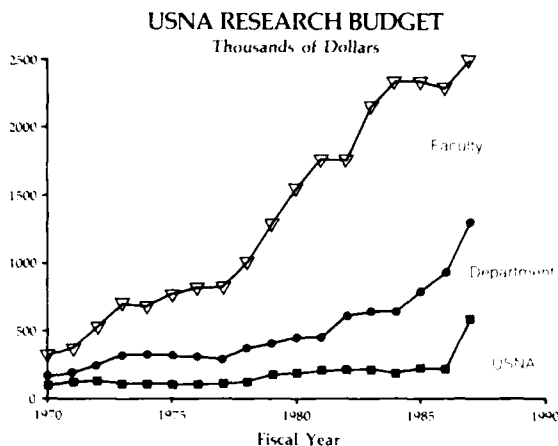


Figure 1: The growth of the research budget since 1970 reflects contributions from Academy-wide programs such as the Naval Academy Research Council and the Instructional Development Program, from academic Department-managed research Memoranda of Understanding and from sponsored projects of individual faculty.

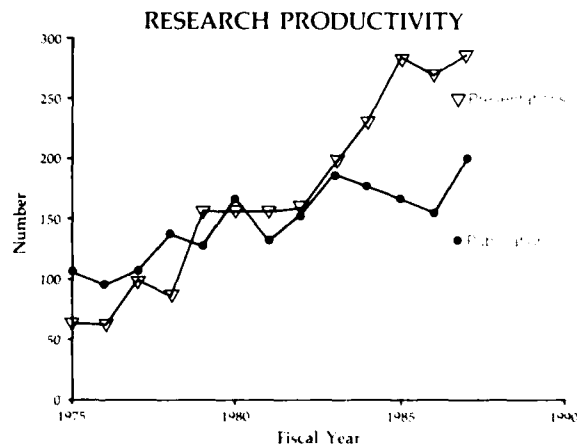


Figure 2: The productivity of faculty and midshipmen, measured through publications and presentations, has increased with the research budget.

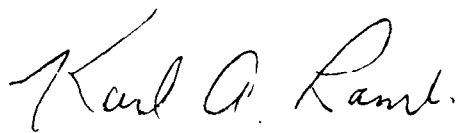
FOREWORD

Midshipmen participation in research at the Naval Academy remains healthy, with one hundred thirty-seven research courses reported, eight Trident Scholars (with seven selected for the coming year) and nearly one hundred midshipmen using summer leave time to work with the Los Alamos National Laboratory, the Johns Hopkins Applied Physics Laboratory, the Oak Ridge National Laboratory, the Lawrence Livermore National Laboratory, the National Security Agency, and the Strategic Defense Initiative Organization.

Further collaboration was developed with new Memoranda of Understanding between the Naval Academy and the National Security Council, the David W. Taylor Naval Ship Research and Development Center, the Director of Naval Warfare, the National Environmental Satellite Data and Information Service, and the Naval Oceanography Command. In addition to research chair holders, the Naval Academy hosted visiting faculty from the Naval Surface Weapons Center and the Naval Personnel Research and Development Center under the Naval Scientist Training and Exchange Program (NSTEP),

from the Royal Naval College, and from various other institutions under the National Faculty Exchange program and the Intergovernmental Personnel Act. This active visiting professor program, along with our sabbatical and travel programs, keeps the Naval Academy in the mainstream of naval and academic research activity.

The Research Office, which oversees this research program, maintains internal communication by means of announcements in its regularly published newsletter as well as in letters and personal discussions. External dialogue is active with the Office of Naval Research, Naval War College, and Naval Postgraduate School as well as the Naval Laboratories, System Commands and Operations. The use of databases is enhancing our ability to coordinate faculty and sponsors; both the Sponsored Program Information Network and internal faculty profiles are presently used, while future benefits are anticipated through wider computer networking. The Naval Academy welcomes all communications regarding research and particularly requests those stimulated by this report.



KARL A. LAMB
Academic Dean



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Division of Engineering and Weapons



Aerospace Engineering

COMMANDER VERNON C. GORDON, USN
CHAIRMAN

Research is an integral part of the growth of any academic institution. It broadens the knowledge base of the faculty, provides an incentive and direction for the student to seek his own special area of interest, and benefits the general population of the institution and the country. In the Aerospace Engineering Department a wide spectrum of research is being conducted in all areas of the engineering sciences.

Our current research efforts are sponsored by the Naval Space Command and Chief of Naval Operations in the area of astronautics; David W. Taylor Naval Ship Research and Development Center for flow field measurements and acoustics; Naval Research Laboratory for low speed aerodynamics; and the Naval Academy Research Council for finite element structure analysis. In addition, members of the faculty are conducting independent research in areas concerning bird aerodynamics, test section flow field visualization, and expanded computer-aided engineering.

This is an important year of growth in the Aerospace Engineering Department. The acquisition process for a LASER velocimeter system is almost complete, with the last components on order. This system will drastically improve future research in aerodynamics, propulsion, and fluid mechanics. The installation of a new satellite tracking and data acquisition facility to expand our ability to conduct space-oriented research has begun. These improvements are complemented with the expanded computational and graphic design facilities that are currently being procured.

The Aerospace Department once again competed in the National Aeronautics & Space Administration (NASA) University Space Research Association (USRA) Advanced Spacecraft Design. Two students presented a paper at the American Institute of Aero-



nautics and Astronautics Regional Student Paper Conference at the West Virginia University, Morgantown, in April.

New research equipment within the laboratory, new computational and graphics capability, and a growing, diverse faculty are indicators of even higher quality research in the years to follow. The Aerospace Engineering Department's goal is to increase our overall research level for faculty enrichment and, more important, to encourage midshipmen to greater levels of participation for their academic advancement.

Sponsored Research

Flow Distribution in the Exhaust System of the ICR/Engine

RESEARCHER: ASSOCIATE PROFESSOR JOHN E. ALLEN

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

A long-term experimental program is being conducted which includes the construction of a Navy owned and operated scale model test facility. Cold air flow tests over the operating range of proposed intercooled regenerative (ICR) engine exhaust flows will result in flow field maps from 5-hole probe, hot wire anemometer, and laser doppler velocimeter

measurements. The complex 3-D flow will be modeled with existing computational codes and validated with test data. The result will be a model to predict full-scale flow distribution with temperature effect for use in design of the next generation of marine gas turbine engines.

Astronautics Curriculum Development

RESEARCHER: VISITING PROFESSOR HAROLD D. BLACK

SPONSOR: NAVAL SPACE COMMAND

The purpose of this sponsored activity was to develop new courses in support of the expansion of the Aerospace Engineering major to include courses in the area of astronautics. The particular area of interest was astrodynamics. The course, Astrodynamics I, EA362, was modified to reflect current state-of-the-art techniques and proven fundamental concepts for the practicing astrodynamists. The

primary goal of this research, however, was to develop a completely new course, EA462, Astrodynamics II. This course was developed and implemented to teach the numerical techniques required in orbit determination, satellite geodesy, and orbital perturbation techniques. A set of detailed test material has been developed and will undergo modification and revision during the next academic year.

Low Speed Aerodynamics

RESEARCHER: PROFESSOR BERNARD H. CARSON

SPONSOR: NAVAL RESEARCH LABORATORY

Small, remotely piloted vehicles have been adopted recently by leading military powers as a means of providing low cost, expendable surveillance platforms. However, the technological base for design of these vehicles is meager. Since they are typically small and fly at low speeds, they fall into an area of aerodynamics predominated by "scale factors." In

the past two years the Naval Research Laboratory has sponsored a number of studies aimed at improving the state of knowledge in the low speed flight regime, including the testing of airfoils and propellers. The present investigation was part of this on-going effort; the project consisted of analysis and interpretation of wind tunnel data.

Hull-Superstructure Interaction

RESEARCHER: ASSISTANT PROFESSOR MICHAEL D. A. MACKNEY

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

The project deals with the complex three-dimensional behavior between the superstructure and hull of a ship under operational conditions. Previous analyses, based on the two beam approach, have been unable to give the insight which modern numerical methods, such as the finite element method, can give.

Following initial literature searches, and parameter identification, a simple hull-superstructure model has been formulated, and a preprocessor written to provide automatic data regeneration for the GIFTS Finite Element processor. User responses

to prompts allow the geometric data and finite element meshing to be created for a group of similar structural models.

The preprocessor is being revised to allow more user inputs for the purpose of defining all plating thickness, and furthering both hull subdivision and loading conditions. Initial proposals have been made for a four model experimental program to be undertaken in support and independent validation of the considerable numerical studies. The work continues with the parametric study using the existing preprocessor, while the more refined models are created.

Computer-Aided Hull Design and Model System

RESEARCHER: PROFESSOR DAVID F. ROGERS

SPONSOR: UNITED STATES COAST GUARD

The Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) system for the design of ship hulls and the production of towing tank models is being refined. New fairing techniques are being investigated, data manipulation routines im-

proved, and alternative forms of data input explored. The feasibility of including other current Coast Guard analysis and design program interfaces in the CAD/CAM system is being studied.



Independent Research

An Evaluation of Two-Dimensional and Axi-Symmetric Focussing of a Plane Shock Wave

RESEARCHER: VISITING PROFESSOR R. DOUGLAS ARCHER

Two-dimensional and axi-symmetric focussing shapes have been designed and tested in a nitrogen/air shock tube with a 150×290mm test section, using a holographic interferometer flow visualization technique, and computer controlled on-line timing. Density can be measured to about 4% (per

fringe). Considerable and fine detail of the imploding and exploding phases of the flow is provided. This degree of detail enables systematic comparison of various shapes both at design and off-design shock Mach numbers.

Flapping Wing Cruising Flight by Birds

RESEARCHER: VISITING PROFESSOR R. DOUGLAS ARCHER

An assessment is made of aerodynamic parameters needed in order to compare cruising flight performance of birds of different species. A review of work done in this area has been accomplished. It is argued that wing aspect ratio is of fundamental importance, and that care is needed in assigning a

representative wing loading. Wing twist and advance ratio are also regarded as of fundamental importance to assess propulsion performance. Quite modest values of lift to drag ratio and propulsion efficiency are indicated, but precise measurement on live birds remains elusive.

Weight Reduction of Suspension Components Using Hollow Bar Stock

RESEARCHER: ASSOCIATE PROFESSOR WILLIAM J. BAGARIA

Research using hollow bar stock instead of solid bar stock for vehicle suspension components as a weight reduction, performance improvement method continues. Suspension components are primarily under torsional loads, thus hollow stock could be used to carry these loads at a significant savings in material

weight. The stress equations have been developed and hardware designed for the investigation. The experimental verification of the theoretical equations remains to be accomplished and will be done upon completion of fabrication of test fixtures.

Naval Academy Rotor Test Facility Flow Model Study

RESEARCHER: ASSOCIATE PROFESSOR GERALD F. HALL

The rotor test facility at the Naval Academy has produced data anomalies during rotor testing. The cause of these anomalies is unclear. A scale model of the rotor test facility with transparent sides is being constructed to investigate this problem. The model test chamber will allow visualization and

more detailed investigation of the complex flow field within the rotor test facility. Upon completion of the scale model testing, the rotor facility will be modified to improve the flow field in the actual test section.

Design Course Projects

Each Astronautics track major in the Aerospace Engineering Department participated in a detailed spacecraft design project that was reviewed by member of the technical staff at the Applied Physics Laboratory, the NASA Goddard Space Flight Center, and by personnel from the Naval Space Command. The students completed a detailed design of a space

vehicle for specified missions. The design included spacecraft systems, orbiter interface, trajectory requirements, and data acquisition system specification. Overall supervision for the course was provided by Visiting Professor George F. Pieper, Dr. Stephen Paddock (NASA), and Mr. Fred F. Mobley (APL).

Space-Based Rescue Capsule

MIDSHIPMEN 1 C ALTON H. COLEMAN, GREGORY N. HARRIS
BRETT A. PIERSON, AND MICHAEL J. QUINN

U.S. Naval Academy Radiation Belt Satellite (RADSAT)

MIDSHIPMEN 1 C MARK J. KOZAR, BRIAN M. LEE, AND WILLIAM R. MUSCHA

COMSAT Communications System

MIDSHIPMEN 1 C RENE MARTINEZ, JONAH WAI SHEN,
BENJAMIN S. SHOVE, AND WAYNE D. TURNER

Galileo II

MIDSHIPMEN 1 C CHRIS COMPEGGIE, KENNETH T. HAM,
BRIAN D. NOYES, AND DARYL S. WAGONER

The Spinning Artificial Gravity Environment

MIDSHIPMEN 1 C JEFFREY C. CRYMES, THOMAS A. MARZEC,
ROBERT P. PIGNATARO, JOSEPH J. SEIBERT, AND JOSEPH G. WALKER

Early Warning Solar Particle Detector Satellite

MIDSHIPMEN 1 C BRIAN N. BURGOS, BRIGITTE HORNER,
JOHN K. MARTINS, AND STEPHEN H. TACKETT

Publications

BAGARIA, William J., Associate Professor, "Undergraduate Astronautics at the United States Naval Academy," Division of Engineering and Weapons Report EW-32-86, December 1986.

This report describes the astronautical engineering track, within the aerospace engineering curriculum, at the U.S. Naval Academy. This track, along with the existing aeronautical track, allows a midshipman to emphasize either astronautical or aeronautical engineering studies. The objective of this course of study is to give the student the necessary astronautical engineering background, so that a preliminary spacecraft design can be accomplished during the last semester of the degree program. This track was developed within the revised ABET guidelines. The revised aeronautical and the new astronautical engineering tracks were approved by the administration of the Academy in May 1986.

CAMPBELL, Bruce A., Lieutenant, USN, "Orbital Mechanics," *Environmental Satellite Program for Naval Oceanography*, Office of the Chief of Naval Operations (OP-952), 1986.

An introduction to the application of orbit mechanics to the design of orbits for Naval Oceanographic missions is presented.

MACKNEY, Michael, D. A., Assistant Professor, "HULGEN-A GIFTS Preprocessor for a Simple Hull-Superstructure Model Toward Interaction Studies," Division of Engineering and Weapons Report EW-25-86, September 1986.

This report describes a doctoral research project on a parametric study of hull-superstructure interaction, concerned with the finite element analysis of a simple hull-superstructure model. In order to provide effective data preparation for a number of conceptually identical models, with geometric variations, a preprocessor was written and tested with Graphical Interactive Finite Element Time Sharing systems (GIFTS) implemented on the Naval Academy Timesharing System (NATS). As well as listing the preprocessor program and typical output, the report describes the simple hull-superstructure model on which it is based, and explains how this is interpreted as a finite element model within the GIFTS processor.

SAARLAS, Maido, Professor, *Steam and Gas Turbines for Marine Propulsion*, Second Edition. Annapolis: Naval Institute Press, 1987.

The first edition (1977) has been updated and expanded to include topics on gas turbines, materials, operation, and technology.

Presentations

ARCHER, R. Douglas, Visiting Professor, "A Study of Bird Flight," College of Engineering and Institute for Physical Science and Technology, University of Maryland, College Park, Maryland, 13 February 1987.

ARCHER, R. Douglas, Visiting Professor, "Bird Aerodynamics - A Study of Flapping Wing Propulsion," Department of Aerospace and Mechanics, University of Minnesota, Minneapolis, Minnesota, 15 May 1987.

BAGARIA, William J., Associate Professor, "Spacecraft Design at the U.S. Naval Academy," National Aeronautics and Space Administration/University Space Research Association Fall Review Meeting, Morrow Bay, California, 1 December 1986.

BAKER, James Matthew and Thomas A. MERCER, Midshipmen 1 C, "VMX Aircraft Design," American

Institute of Aeronautics and Astronautics Mid-Atlantic Regional Student Conference, West Virginia University, Morgantown, West Virginia, 10 April 1987.

GORDON, Vernon C., Commander, USN, William J. BAGARIA, Associate Professor, and Bruce A. CAMPBELL, Lieutenant, USN, "A Review of the Current Status of the Astronautics Track of the Aerospace Engineering Major at the U.S. Naval Academy," Chief of Naval Operations, Naval Space Command Curriculum Review, U.S. Naval Academy, 13 April 1987.

MACKNEY, Michael D. A., Assistant Professor, "Laying the Foundations for Quality Assurance During Early Educational Courses in the Finite Element Method," International Conference on Quality Assurance and Standards in Finite Element Analysis, Brighton, England, 13-15 May 1987.





Electrical Engineering

LIEUTENANT COLONEL GEORGE D. PETERSON, USAF
CHAIRMAN

Research in the Department of Electrical Engineering serves three purposes: it supports continuing development of the faculty; it provides the important element of applied engineering for midshipmen who participate in projects; and it contributes new knowledge to the disciplines. The second of these purposes is the most important at the Naval Academy. Research must provide the basis for a strong undergraduate program. Therefore, in addition to advancing the frontiers of their research areas, faculty members are committed to maintaining dynamic and challenging projects for midshipmen who choose to specialize in electrical engineering. Participating midshipmen have the opportunity to engage, with faculty, in unstructured scientific effort of a wide variety. Thus, they are exposed to some of the techniques applied to the solution of practical engineering problems. Research activity provides midshipmen the opportunity to learn how the engineering community responds to the ever-expanding needs of the service.

The research currently performed tends to concentrate on fleet problems. The results benefit our operating forces and introduce midshipmen to relevant topics which enhance their professional as well as academic growth.



Sponsored Research

Wire Antennas for Tactical Communications

RESEARCHER: CAPTAIN WARREN P. AVERILL, USMC
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

The vast majority of Marine Corps communications between distant commands is via satellite. In times of crisis, long-range communications become the lifelines of support for forces on far away shores. In the President's 1984 (23 March) speech, he reminded the nation that the battlefield will soon extend into space. In such a scenario, communications satellites may very well be among the first casualties. The Marine Corps is presently ill-prepared to use the alternative means of communicating: high frequency (HF) communication (3-30 megahertz). Few communicators possess the knowledge and expertise required to set-up and maintain reliable HF links.

The objective of this project is to develop a propagation analysis and antenna design program which

can be used as a tool by tactical communicators. This research is combining the products of two agencies; an extensive antenna study conducted at Lawrence Livermore National Laboratory and a propagation analysis program written at Naval Ocean Systems Center (NOSC). With this new program the communicator will have a tool which requires a minimum of information input and a minimum of decisions. The output will be simply-stated instructions on how to set up the antenna and guidance on the proper use of the frequencies available. This project was a collaborative effort with the Marine Corps Development Center, Quantico, Virginia.

Computer-Aided Motor Design

RESEARCHER: PROFESSOR FRANCIS J. EBERHARDT
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

This is a continuing program for the development and use of computer-aided design programs for the modelling and evaluation of acyclic, homopolar high power propulsion motors. In the 1986 interseasonal period three tasks were undertaken: (1) Collection of data from the design programs to assist in the evaluation of machine performance when

magnetic steel is also used as a conductor for armature current; (2) Continue consolidation and documentation for the normal and superconducting design programs; and (3) Make some rough comparisons of the characteristics of the motor design using liquid metal current collectors and solid brush collectors.

Detection of Contaminants in Fluids by Ultrasonic Measurements and Spectral Analysis

RESEARCHER: ASSISTANT PROFESSOR DAVID S. HARDING

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The objective of this project is to develop a system which can identify and characterize particulate contaminants in fluid flow by use of ultrasonic pulse echoes. The ultrasonic pulses used are produced by a wideband pulser-transducer system, so that spectral features produced by various targets can be explored over a wide range of frequency. Features of the ultrasonic pulse echoes in both the time and frequency domains can be used to characterize the

target. This capability has applications in the monitoring of lubrication and hydraulic systems on board naval ships. Early detection of solid, metallic wear particles can enable preventive maintenance to be performed. It is essential to differentiate air bubbles from solid targets, because air may be entrained in oil flow. Thus far the experimental system can identify a single air bubble or a solid particle.

The Electronic Classroom

RESEARCHERS: MAJOR FRANCIS P. LANZER, USMC,

ASSOCIATE PROFESSOR WILLIAM E. BENNETT,

ASSISTANT PROFESSORS PATRICIA E. BURT AND DAVID S. HARDING

SPONSOR: NAVAL ACADEMY INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE

The electronic classroom is an educational facility consisting of an instructor's console, a large screen projector, and linked personal computers. This system was constructed in a classroom, was prototyped for one semester, and used for instruction during the Spring 1987 semester for approximately 100 students. The section size limit is 16. The concept was not to replace the professor, or force a change in personal styles of instruction, but to enhance the presentation of the material. This system is not a true local area network. The feedback path is still via the instructor, not through isolated consoles. The software used was chosen for its ease of use, suitable graphics for presentation, and availability of site licenses at a reasonable cost.

The project was a success. Students taught in the electronic classroom performed better than those who were not, provided that suitable software was available for the topics being studied. This classroom will be moved to a larger room and expanded to handle the regular section size of 24. Important lessons learned include allowing extra time at the start of the course for students to gain familiarity with both the computers and the software, and that the biggest advantage of the computer-aided instruction is more frequent, faster, and more varied demonstrations of electronic principles.

Circuit Design for Nuclear Radiation Test of CMOS Chips

RESEARCHER: ASSOCIATE PROFESSOR TIAN S. LIM

SPONSOR: NAVAL RESEARCH LABORATORY

This is ongoing research devoted to designing circuits and developing procedure for testing and evaluating the effects of nuclear radiation on CMOS chips.

Alteration of the electrical properties of integrated circuits by impinging radiation may cause an

electronic subsystem to malfunction. Therefore, it is important to devise methods to avoid radiation-induced degradation. An important step in developing hardened electronics is gaining an understanding of the effects produced in integrated circuits by radiation.

Evaluation of Nuclear Radiation Effects on Very Large Scale Integrated (VLSI) Circuit Components

RESEARCHER: PROFESSOR RICHARD L. MARTIN

SPONSOR: NAVAL RESEARCH LABORATORY

The purpose of this work is to develop procedures for testing and evaluation of the effects of different types of nuclear radiation on prototype VLSI components. Specifically, the different effects and dam-

age mode of gamma radiation and neutron radiation are to be determined. The work is currently in progress.

Wear Particle Characterization by Ultrasonic Signal Processing Techniques

RESEARCHERS: PROFESSOR ANTAL A. SARKADY

AND ASSISTANT PROFESSOR DAVID S. HARDING

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

Wear rate and failure time of shipboard machines can be predicted by online monitoring of wear particles in lubricants. This information is essential in scheduling maintenance. Presently, solid wear particles in oil can be adequately counted and sized using ultrasonic pulse echo techniques, but entrapped air and water in the oil can lead to false readings.

Current research work is concentrated on tabulating the ultrasonic signal features of air bubbles (of 1 to 2mm in size) and metal spheres (of .0001 to .001mm in size) suspended in fluids and measured in the 1 to 15 MHz frequency range.

Estimating Radiation Conductance of a Thickness-Mode Transducer from Driving-Point Admittance Measurements

RESEARCHERS: PROFESSOR ANTAL A. SARKADY, AND

ASSOCIATE PROFESSOR (RETIRED) HERBERT M. NEUSTADT

SPONSOR: NAVAL RESEARCH LABORATORY

For many thickness-mode transducer applications, it is desirable to have a good estimate of the transducer's radiation conductance, G_{RAD} . Generally, however, it is difficult to measure directly transducer power output. It is therefore desirable to have a procedure for estimating G_{RAD} from easily measurable parameters. A promising candidate for such a procedure is to measure the driving-point conductance of the transducer when it is in air, and when in water. These measurements are made at the transducer's lowest single-peak resonance frequency. The estimated radiation conductance is the driving-point conductance in air minus that in water. This procedure was applied to six transducers considered

to be representative of the most popular types. The results were compared with measurements made at National Bureau of Standards (NBS) by use of a force balance. For four transducers, the lowest resonance frequency was clearly defined by a single peak in the transducer's driving-point conductance vs. frequency curve. For these four, the discrepancy between the NBS radiation conductance values and the researchers' values was within 4%. For the other two transducers, the "lowest single-peak resonance frequency" could not be readily determined because of two overlapping peaks in the driving-point conductance vs. frequency curve. The investigation is being continued.

Independent Research

Electron Excitation of 6^+ States in ^{32}S

RESEARCHER: ASSISTANT PROFESSOR PATRICIA E. BURI

A search for the $\ell=0$ magnetic multipole (M0) transition strength in ^{32}S nuclei is proposed. A primary objective of the experiment is to examine the effect of the $2s_{1/2}$ spectator orbit on the distribution of M0 strength in the s-d shell. Systematic studies of $A=12 \rightarrow 16$ and $A=56 \rightarrow 60$ nuclei show that M4 and M8 transitions, respectively, are consistently strong. A similar behavior is expected in the $A=28 \rightarrow 32$ nuclei, in particular ^{32}S , because of the

known large M0 strength in ^{28}Si . Preliminary inelastic proton scattering experiments, however, fail to indicate such strength in ^{32}S . In order to understand the cause of this disagreement, the researcher proposes to study ^{32}S using a more sensitive probe, inelastic electron scattering. Experiments are proposed primarily at $\theta=154^\circ$ in the momentum transfer range $1.1 < q < 3.0 \text{ fm}^{-1}$, and excitation energy range $14 < E_m < 17.5 \text{ MeV}$.



Publications

BENNETT, William E., Associate Professor, and David S. HARDING, Assistant Professor, "Uses of PSPICE in the Electronics and Signals & Systems Curricula at the United States Naval Academy," *Proceedings of The 1986 Frontiers in Education Conference*, October 1986, 215-223.

In this paper the authors describe the use of PSPICE run on the IBM-XT as a tool to teach several important concepts in electrical engineering. PSPICE is a comprehensive circuit analysis program designed to run on microcomputers. The Electrical Engineering Department at the United States Naval Academy has recently acquired approximately a dozen IBM-XT microcomputers, and this paper describes a first attempt by the authors at the use of PSPICE as an educational tool.

In one application the student uses PSPICE to predict the operation of an active RC circuit that implements a stable oscillator. This task involves deriving the frequency of oscillation analytically, verifying the oscillator performance with the PSPICE computer simulation, and then actually testing the oscillator circuit in the laboratory. The computer evaluation was done by simulating the circuit with PSPICE for gains less than critical, equal to critical, and greater than critical. The active device used was an operational amplifier; hence the need to simulate circuit performance with PSPICE. The oscillator circuit that was chosen was one not normally encountered in standard texts. The overall result was that the student found the analytical solution, the computer stimulation, and the performance of the actual hardware all correlated well.

In the signals and systems area the authors describe the investigation of an under-damped series RLC circuit using both pulse and sinusoidal excitations. In particular, the student uses PSPICE to find an excitation pulse short enough that the response approximates the impulse response well. In addition the student investigates the natural frequency of the

RLC circuit and its relationship to the resonant frequency.

LIM, Tien S., Associate Professor, "Circuit Design for Nuclear Radiation Test of CMOS Multiplier Chips," *Institute of Electrical and Electronic Engineers Circuits and Devices Magazine*, 2, 5 (September 1986), 29-33.

This paper describes the design of a microprocessor-based electronic circuit to be used in testing the effects of nuclear radiation on a CMOS multiplier chip. The chip undergoing testing is attached to a DUT (device under test) board which is enclosed in a metal container. The container is then lowered to the cobalt 60 radiation source located at the bottom of a pool with a depth of 15 feet. The in-source test board containing the multiplier chip is attached to an 8085-based, single-board microcomputer by a 30-foot multi-conductor cable. Doses of gamma-ray radiation from cobalt 60 are applied in steps at increasing quantities until the multiplier chip begins to malfunction. An 8085 assembly language program is used for functional testing of the multiplier. The leakage current and the propagation delay time are also measured between doses.

LIM, Tian S., Associate Professor, "Nuclear Radiation Test of a D Flip-Flop IC Using a Single-Board Microcomputer," *Institute of Electrical and Electronic Engineers Circuits and Devices Magazine*, 3, 1 (January 1987), 22-30.

In this paper the design of a microcomputer-controlled circuit and its use in evaluating the effect of nuclear radiation on a 4013 CMOS D flip-flop integrated circuit are described. The software design and the radiation testing procedure are discussed in detail.

Presentations

BENNETT, William E., Associate Professor, and David S. HARDING, Assistant Professor, "Uses of PSPICE in the Electronics and Signals & Systems Curricula at the United States Naval Academy," 1986 Frontiers in Education Conference, Arlington, Texas, 14 October 1986.

HARDING, David S., Assistant Professor, "Detection of Contaminants in Fluids by Ultrasonic Measurements and Spectral Analysis," Sixteenth Symposium on Non-destructive Evaluation, San Antonio, Texas, 21 April 1987.





Mechanical Engineering

PROFESSOR JOSEPH D. GILLERLAIN, JR.
CHAIRMAN

Faculty and midshipmen research in the Mechanical Engineering Department covered many varied areas of specialization within the broad field of mechanical engineering. These areas included fluid mechanics, energy conversion, internal combustion engines, composite materials, and fatigue and corrosion of advanced aluminum alloys, as well as applications of artificial intelligence.

Research was supported by a variety of sponsors, including the Office of Naval Research, the David W. Taylor Naval Ship Research and Development Center, the United States Coast Guard, the Nuclear Regulatory Commission, and several private corporations. Additionally, a significant amount of untended research was undertaken independently by faculty members in their specific areas of technical expertise and personal interest.

As is the case of any academic institution, the primary driving force behind research at the Naval Academy is the need for faculty to stay abreast of current developments in the many diversified areas of engineering in order to be more effective classroom instructors. The efforts of the mechanical engineering faculty toward the accomplishment of this goal are evidenced by the extensive number of publications and presentations at technical conferences worldwide.



Sponsored Research

Deep Submergence Cooling Systems

RESEARCHER: ASSOCIATE PROFESSOR ELLIOTT E. DODSON
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The purpose was to assess the most promising concepts of advanced cooling systems and or components for deep depth submergence and provide re-

search and development recommendations to the program manager. Project is classified.

Investigation of Smoke Nuisance on Surface Effect Ships

RESEARCHERS: PROFESSOR JOSEPH D. GILLERLAIN, JR., AND
ASSOCIATE PROFESSOR JOHN E. ALLEN (AEROSPACE ENGINEERING)
SPONSOR: UNITED STATES COAST GUARD

The second phase of this project involved comparisons of computational codes for stack design and stack plumes. Existing codes currently in use were studied, and theoretical results were compared

with previously obtained experimental measurements. Other commercially available computational codes were considered. The work is in progress.

Impact Toughness of Ceramic Matrix Composites

RESEARCHER: PROFESSOR DENNIS F. HASSON
SPONSOR: OFFICE OF NAVAL RESEARCH

Research proceeds on the effect of high loading rate on the fracture mechanisms for crack formation and propagation in ceramic matrix composite materials of various architectures. Instrumented bend specimens were tested at high loading rates in both a pendulum and drop tower apparatus. Macro- and micro-fractography was performed to determine the

modes of fracture from fracture morphology. The information was analyzed to provide insights for toughening of advanced ceramic matrix composite materials. Additional testing to determine the effect of impact loading in the short transverse direction is in progress.

Mechanical and Impact Toughness Properties of Advanced Aluminum Alloy Materials

RESEARCHER: PROFESSOR DENNIS F. HASSON
SPONSOR: NAVAL SURFACE WEAPONS CENTER, WHITE OAK LABORATORY

The purpose was to determine which manufacturing process of advanced aluminum alloy materials provides the best mechanical and impact properties. Mechanical properties were determined, for example, for rapidly solidified powder metallurgy and mechanically alloyed powders. Macro- and micro-scanning electron microscope fractography was

performed to determine fracture modes and mechanisms. Various products from either hot pressing extrusions and/or forging were also examined. Additional testing of alloys has been performed to show the effects of aging time on properties. Orientation effects on impact behavior of advanced aluminum-lithium alloys also have been measured.

Temperature Effect on the Impact Properties of Titanium Aluminide Materials

RESEARCHER: PROFESSOR DENNIS F. HASSON

SPONSOR: NAVAL RESEARCH LABORATORY

The purpose is to determine the ductile-to-brittle-transition temperature (DBTT) of extruded titanium aluminides with different dispersed particulates, such as titanium diboride and titanium carbide. The DBTTs of these materials have not been determined, but they are estimated to be in excess of 800 °C. The

impact tests are being performed in an instrumented drop tower which allows for some variance in impact velocity and energy. Macro- and microfractography are planned to determine fracture modes and mechanisms.

Application of Artificial Intelligence Language— Prolog to Data Base Query

RESEARCHER: ASSOCIATE PROFESSOR RUSSELL D. JAMISON

SPONSOR: NAVAL RESEARCH LABORATORY

The purpose was to establish a data base of experimental fatigue data from composite testing and to study the feasibility of providing a query protocol using the Prolog language by which the data base

could be examined efficiently to yield relationships among the data which would otherwise be undetected.

Behavior of Impact-Damaged Graphite/Epoxy and Hybrid Laminates Under Fatigue Loading

RESEARCHER: ASSOCIATE PROFESSOR RUSSELL D. JAMISON

SPONSOR: ALLIED CORPORATION

The purpose was to study and characterize the growth of damage in impact-damaged composite laminates under tension fatigue loading.

Measurement of Elastic Properties of Polymers at Extreme Temperatures

RESEARCHERS: ASSOCIATE PROFESSOR RUSSELL D. JAMISON

SPONSOR: WESTINGHOUSE

The purpose of this research was to measure Young's modulus, Poisson's ratio, and the coefficient of ther-

mal expansion for PMMA and Kapton film to support Westinghouse's acoustics program.

Dynamic Elastic Plastic Fracture

RESEARCHER: PROFESSOR JAMES A. JOYCE
SPONSOR: NUCLEAR REGULATORY COMMISSION

The purpose and objectives were to (1) utilize drop tower test procedures to evaluate dynamic fracture toughness of A533B steel in the toughness transition region, and (2) investigate criteria for cleavage crack initiation in A533B steel in the upper transition region. To date, static tests on compact and bend specimens have been completed at temperatures from -80°C to 150°C . Drop tower rate tests have been run at temperatures from -60°C to $+80^{\circ}\text{C}$,

but the series is only now being repeated to give a larger data base for statistical analysis. Large scale specimens, approximately 16-inch long bend bars, have been machined and will be tested this summer. Results to date show that the exceptional care taken with these tests had greatly reduced the data scatter reported by previous researchers. The adequacy of J integral analysis will be determined after the larger scale tests have been completed.

Shock Test of Self-Lubricating Bearings

RESEARCHER: ASSOCIATE PROFESSOR WILLIAM M. LEE
SPONSOR: NAVAL SEA SYSTEMS COMMAND

An investigation was conducted to determine the shock resistance characteristics of nonmetallic self-lubricating bearing materials that are being considered as replacements for existing metallic bearings in torpedo tube linkage systems. Candidate materials have been previously screened, yielding 4 materials with friction, wear, and creep proper-

ties that compared favorably with existing materials. These materials were ultra high molecular weight (UHMW) polyethylene, plus 3 proprietary materials identified as codes A, B, and C. These materials were subjected to tests meeting the requirements of the MIL-S-901C for 637 and 688 class submarine torpedo tube bearing applications.

Analysis of Flow Induced Noise in Pipes

RESEARCHER: PROFESSOR JOHN P. ULDRICK
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

This project is an experimental investigation of the structural response of simple piping configurations to the flow of water through them. Special emphasis was placed upon the development of mathematical models for predicting both the structures vibration

response and the fluid borne spectra. A comprehensive course on Modern Dynamic Signal Analysis was developed and presented to some twenty-five scientists and engineers at David W. Taylor Naval Ship Research and Development Center.

Independent Research

Teaching and Learning Strategies in the Computer Age

RESEARCHER: ASSISTANT PROFESSOR SHIRLEY T. FLEISCHMANN

The present generation of students has been raised in a period of tremendous technical and social change. As a result their childhood background is, in many cases, significantly different from what their teachers was at that same age. Little attention has been given to the effect of tremendous change on those who are now too young to remember the days before calculators, digital clocks, and a myriad of new products and processes. Evidence gathered

from observations of students indicates that the impact of the changes (which their teachers experienced as adults, but which students experienced in their formative years) is indeed significant. The effectiveness of an entire education approach is threatened. Continuing research involves discovery of the depth of the problem and also classroom techniques designed to overcome the problems.

Transition to Turbulence — Effects of Surface Roughness and Free-Stream Noise

RESEARCHER: ASSISTANT PROFESSOR SHIRLEY T. FLEISCHMANN

It is well known that surface roughness and free-stream turbulence do effect transition to turbulence; however the possible interaction of these effects and reliable methods to predict transition (if surface roughness and free-stream turbulence are known) have not been extensively studied. Research on

roughened circular cylinders has been done, and current research is focusing on flow over flat plates with possible application to controlling transition on ship models as an immediate goal. Experiments on flat plates in water flow are being planned.

Residual Strength of Aramid Fiber-Reinforced Aluminum Sheet After Fatigue Testing in Lab and Salt-Contaminated Moist Air

RESEARCHER: PROFESSOR DENNIS E. HASSON

Aramid fiber-reinforced aluminum sheet was tested to various levels of fatigue life. The specimens are subsequently tested for residual strength. The fatigue tests are performed in both lab and salt-

contaminated moist air. Scanning electron microscope fractography was performed to determine fracture path and the contribution of the aramid fibers to the fatigue resistance.

Post Processor Development

RESEARCHERS: PROFESSOR JAMES A. JOYCE WITH ROBERT LEHR

The objective is to develop a post-processor capability for VAX Fortran finite element analysis using a Tektronix color graphics terminal. Plastic zone development plots were generated from this task, which demonstrated how permanent damage is accumulated near a crack tip as the load intensity is

incrementally increased. Application of this computer program was made to a U.S. Navy problem involving butt-welded joints which have preexisting cracks caused by incomplete weld penetration during fabrication. This project was developed under the Naval Academy Mentorship Program.

Research Course Projects

Endoreversible Energy Conversion

RESEARCHER: MIDSHIPMAN 1 C CLAUDE P. LIM

ADVISER: PROFESSOR CHIH WU

An endoreversible cycle is a reversible Carnot cycle modified by adding time factor and irreversibility in the heat transfer processes with the surroundings of the cycle. Energy conversion characteristics of an endoreversible heat engine at its maximum power condition, and of an endoreversible heat pump, as well as refrigerator at its respective minimum input

power condition, are treated analytically. Computer simulation of the performance of the endoreversible energy conversion devices is made. The results give a very reasonable bound for energy conversion engineering designers and a realistical limit in evaluation of existing energy devices.



Publications

FLEISCHMANN, Shirley T., Assistant Professor, "Drag on a Stationary Circular Cylinder in Cross-flow - A Laboratory Exercise," Division of Engineering and Weapons Report EW-20-86, 1986.

A new experiment, "Drag on a Stationary Circular Cylinder in Cross-flow," is currently available in the (blue) subsonic wind tunnel at the U.S. Naval Academy. In the lab the drag on a circular cylinder ($D=3"$, $L=54"$) is measured using three methods: (1) a direct force measurement using a force transducer, (2) the integration of the pressure distribution around the cylinder, and (3) a control volume analysis utilizing a wake velocity survey.

The sample results given in this report are $CD=1.16$ by method 1, $CD=1.18$ by method 2, and $CD=1.4$ by method 3. These results compare very favorably with the accepted experimental value of $CD=1.2$ at $Re=1.8 \times 10^5$. The experiment has been designed to provide results for a laminar boundary layer and a fully turbulent wake at all tunnel speeds. The experiment uses both manual and automated measurement systems; therefore, in addition to demonstrating 3 different methods to obtain a drag coefficient, it illustrates the advantages and disadvantages of these measurement systems.

The lab has been used very successfully in the Mechanical Measurements course (EM471) and in Fluid Dynamics (EM324). This report contains the lab handout, sample results, an equipment list, a detailed experimental schematic with instruction for setup, and notes to the instructor.

HASSON, Dennis F., Professor, co-author, "Impact Behavior of Ceramic Matrix Composite Materials," Sixth International Conference on Composite Materials, Imperial College, England: Elsevier Applied Science Publishers, LTD, 1987, pp. 2.40-2.47.

Ceramic and ceramic matrix composites with continuous SiC fibers in a lithium aluminosilicate ma-

trix were tested in a low blow instrumented impact apparatus. The composite architectures were unidirectional (0°) and crossply ($0/90^\circ$). An early development laminate with a borosilicate glass matrix and graphite fibers was also tested. The fiber-matrix frictional sliding mechanism, which is responsible for improved ceramic matrix composite static toughness, is also operative at elevated loading rates. Also, the impact toughness of these composites is much greater than for their monolithic ceramic matrix.

HASSON, Dennis F., Professor, co-author, "Flexural Fatigue Behavior of Aramid-Reinforced Aluminum 7075 Laminate (ARALL-I) and AL 7075 Alloy Sheet in Air and in Salt-Laden Humid Air," *Proceedings of the Sixth International Conference on Composite Materials*, Imperial College, England: Elsevier Applied Science Publishers, LTD, 1987, pp. 2.138-2.145.

Fatigue and corrosion fatigue studies were conducted in flexure on aramid-reinforced aluminum laminate (ARALL-I) in lab and salt-laden moist air. The ARALL results are compared to data for AL 7075-T6 and AL 7075-T73 alloy sheet. In lab air, the ARALL-I showed enhanced fatigue endurance behavior and at 10^7 cycles to failure, an improvement in stress-carrying ability of 12 ksi (83 MPa) is achieved. In the salt-contaminated, moist air environment, the ARALL-I showed about 15 ksi (103 MPa) improvement in load-carrying capability in the low cycle fatigue range, whereas in high cycle fatigue, the enhanced fatigue behavior of the ARALL-I is somewhat less. Micro- and macro-examination of the fatigued specimens showed that the outer laminates of the ARALL cracked early in the fatigue life and eventually delaminated. Damage to the fibers was not observed until near the end of the fatigue life. When flexed in a direction transverse to the direction of the fibers, the fatigue life was dominated by fatigue of the 7075 Al laminate sheets.

JAMISON, Russell D., Associate Professor, "Microscopic Techniques for Damage Assessment in Laminated Composites," *Microstructural Science, Vol. 14. Welding, Failure Analysis, and Metallography*, eds. Mrs. Louham, Jr., I. Lemax, and G. F. VanderVoort, 1987, pp. 539-559.

Several microscopic techniques recently have proven to be very useful in the assessment and characterization of damage in composite laminates. This paper describes two of these: stereo x-ray radiography and laminate deply. These techniques were applied to the study of damage development in graphite/epoxy laminates subjected to both quasi-static and cyclic tensile loading. By the use of an x-ray enhancing agent and an aerial photogrammetry viewer, insights into the microscopic details and through-thickness location of matrix damage were possible through radiography. Interaction between matrix cracks and interior delaminations were documented for the first time, and a source of porosity entrapment was identified.

A laminate deply technique was used to expose internal broken fibers for *in situ* examination with a scanning electron microscope. Among the results presented are evidence of a strong interaction between matrix cracks and fiber breaks and of the occurrence of fiber breaks in isolated small groups.

Descriptions of the techniques are provided in detail. Illustrations from previous work are presented.

JAMISON, Russell D., Associate Professor, "Survey of Recent Research in Thick Composite Laminates," Division of Engineering and Weapons Report EW-21-86, 1986.

Recent research in the area of thick composite laminate is reviewed. The areas of fabrication, analysis, and testing are emphasized. Representative papers in the technical literature are reviewed. Key areas for continued research are identified.

JAMISON, Russell D., Associate Professor, "Measurement of Elastic Moduli of Polymers," Division of Engineering and Weapons Report EW-26-86, 1986.

Values of Young's Modulus (E) and Poisson's Ratio (ν) for specimens of polyurethane and Kapton[®] were measured using strain gages over the temperature range -60°F to 160°F . The coefficient of thermal expansion (CTE) for these materials was also measured over the same temperature range. Bulk modulus (K) was calculated from these measurements.



JAMISON, Russell D., Associate Professor, "On the Interrelationship Between Fiber Fracture and Ply Cracking in Graphite Epoxy Laminates," *Composite Materials: Fatigue and Fracture*, ASTM STP 907, ed. H. T. Hahn, Philadelphia: American Society for Testing and Materials, 1986, pp. 252-253.

The present work examines in a systematic way the development of microdamage in several laminates of graphite epoxy material subjected to both quasi-static tensile loading and tension-tension fatigue. Emphasis is placed upon discriminating and quantifying matrix and fiber microdamage. Penetrant-enhanced standard and stereo X-ray radiography were used, along with edge replication, to follow the progression of matrix damage. The recently developed technique of laminate deply was used to map the development of fiber fracture.

The most significant result, confirmed in both the quasi-static and fatigue tests, was the dominant role played by off-axis ply cracks in the fracture of fibers in adjacent load-bearing plies. By direct observation of fiber fractures *in situ*, it was established in both cases that fiber fractures do not occur in a random pattern at elevated loads, cycles, but instead occur in narrow bands adjacent to off-axis ply cracks. It is the action of these crack tips upon adjacent fibers which may govern the wearout or overload of laminates under these conditions.

By direct accounting of fiber fractures in depled laminate taken from damaged but unfailed laminates, the relationship between the density of fiber fractures and the number of cycles at one cyclic stress level is reported. The relationship between fiber fracture density and quasi-static stress level is reported as well.

For the quasi-statically loaded specimens, efforts to characterize and discriminate between fiber fracture and transverse ply cracking on the basis of acoustic emission (AE) amplitude distribution are described. Correlations between attributes of the AE amplitude distribution and the established damage extent and chronology are reported. Common assumptions regarding the contributions of these distinct damage modes to acoustic emission from laminates under tensile loading are discussed in terms of the present evidence.

Finally, in comparing damage resulting from quasi-static tension loading of cross-ply laminates with that observed in tension-tension cyclic loading of laminates of similar graphic epoxy material, microdamage modes unique to fatigue are identified and discussed.

JAMISON, Russell D., Associate Professor, co-author, "Use of Graphite Epoxy Composites in Spacecraft Structures: A Case Study," *Johns Hopkins APL Technical Digest*, 7, 3 (July-September 1986), 290-294.

The feasibility of using graphite epoxy composites in the fabrication of critical structures in support of APL programs is demonstrated by a redesign of the POLAR BEAR satellite's only support structure. The new technology can also be applied to the other programs throughout the laboratory and elsewhere.

JOYCE, James A., Professor, "Dynamic J-R Curve Testing of a High Strength Steel Using the Key Curve and Multispecimen Techniques," *Fracture Mechanics: Seventeenth Volume*, ASTM STP 905, eds. J. H. Underwood, R. Chait, C. W. Smith, D. P. Wilhem, W. A. Andrews, and J. C. Newman, Philadelphia: American Society for Testing and Materials, 1986, pp. 741-774.

J-intergral R-curve tests were performed on three-point bend specimens of a 3-Ni steel at three loading rates: quasi-static, intermediate (25 mm/s), and drop tower (2.54 m/s). The key curve and multispecimen procedures were employed for the higher rate tests; this investigation is focused primarily on details of the test method development. The multispecimen and key curve techniques were found to yield upper shelf J-R curves which were in substantial agreement at the elevated loading rates. Numerical smoothing techniques required to apply a key curve method appear to separate the oscillatory high frequency component from the load-displacement record. For the 3-Ni steel tested for this investigation, both J_k and T were found to be elevated with increasing loading rate.

JOYCE, James A., Professor, co-author, "**Application of Alternating Current Potential Difference to Crack Length Measurement**," United States Nuclear Regulatory Commission, Washington, DC. Report NUREG CR-4699, (August 1986).

The objective of this project has been to investigate the applicability of an alternating current potential difference method of crack length estimation to rapid loading fracture mechanics tests in ferromagnetic materials.

The more commonly used direct current method has been demonstrated to be very sensitive to induced magnetization under rapid loadings. The resulting direct current output signal is complex and not repeatable, and the component related to crack extension cannot be separated from the total response. The tests done here show calibrations of a 10kHz alternating current system on an A533B material and application of the calibration to a static unloading compliance test and to rapid servohydraulic tests. A d.c. component dependent on stress-induced magnetization is still present but can now be separated from the high frequency component using Fourier series methods.

The major conclusion is that an alternating current technique with a properly chosen excitation frequency can be used to detect crack growth in rapidly loaded specimens. Additional comments on developing an improved system are presented.

JOYCE, James A., Professor, co-author, "**Development of an Analytic Key Curve Approach to Drop Tower J-R Curve Measurement**," United States Nuclear Regulatory Commission, Washington, DC. Report NUREG/CR-4782, (December 1986).

The report describes the development of a dramatically improved method for evaluating J-R curves from 3 point bend specimens tested in a drop tower at loading rates of 2.5 m second. Aluminum ab-

sorbers are used to eliminate the initial transient shock and produce data records smooth enough for direct application of key curve methods. An analytic key curve method is used which eliminates the need for tests on blunt, notched, or subsize specimens, allowing development of a J-R curve for each specimen tested. Results are presented on an A533B steel, showing the resulting J-R curve elevation as a function of test rate in comparison with standard static tests.

JOYCE, James A., Professor, "**Transition Range Drop Tower J-R Curve Testing of A106 Steel**," United States Nuclear Regulatory Commission, Washington, DC. Report NUREG/CR-4818, (February 1987).

Fracture toughness properties should be measured in the laboratory at loading rates and temperatures similar to those expected in the application of interest. This is not usually the case because of the experimental difficulties involved. This report describes a method being used to obtain J_{IC} , J-R curves, and J at cleavage for three point bend tests conducted at drop tower rates through the ductile to brittle transition regime of the ferritic A106 steel being tested. The major conclusion is that these tests can now be accomplished, though a high degree of expertise and considerable practical experience are necessary to obtain good test results. The steel tested here is quite rate dependent, as shown both by tensile tests and fracture toughness tests. A load elevation of 30% to 50% results in the drop tower 100 in/second test on this material in comparison with static tests when both tests are conducted on the ductile upper shelf. Nonetheless, for this material, J_{IC} and J-R curves are not elevated by the loading rate. This rather surprising result corresponds to a tendency for crack initiation to occur at a smaller bend angle beyond crack initiation than is present in the static test.

KEATING, Eugene L., Professor, co-author, "Octane Insensitivity of Supercharged I.C. Engines Using Chemical-Acoustic Charge Conditioning," American Society of Mechanical Engineering Report 87-ICE-23, 15 February 1987.

Supercharged I.C. Engine performance maintaining MBT spark with a low octane fuel is demonstrated in a 1.6 L production engine, using time dependent pulse combustion generated by a resonating piston cavity. Octane insensitivity of this combustion process employing chemical acoustic interaction is demonstrated in a power-spark-boost map by maintaining MBT spark up to 8 psi (.55 bar) from 600 to 4000 RPM for a fixed octane number fuel. The relationship of time dependent combustion in such I.C. engines to a Helmholtz oscillator tuned to the knock frequency of the combustion chamber is demonstrated experimentally. Control of end gas reaction rate within the cavity allows periodic addition of preconditioned mixture to the combustion process at a predetermined rate rather than in the autocatalytic runaway manner of the knock process. Without optimization of the manifolds, fuel delivery system, valve gear, etc., at a boost pressure of .55 bar using 87 octane (R+M)/2 fuel, a BMEP of 16.6 bar at 3000 RPM, MBT spark, has been attained.

KEATING, Eugene L., Professor, co-author, "Evidence for Chemical-Acoustic Interaction for I.C. Engines," American Institute of Aeronautics and Astronautics Report 86-0527, 6 January 1986.

The key concepts of the time dependent I.C. engine combustion with internal regeneration are reviewed briefly. Time dependent combustion in such I.C. engines is a result of a tuned Helmholtz cavity excited by combustion pressure waves. Mass exchange from within the cavity prolongs the combustion time and at the same time allows end gas control through control of its mixture composition and temperature; damping of standing waves is also observed. Internally regenerative aspects of these engines stem from both thermal and chemical effects. Theoretical and experimental evidence of such behavior in single and multicylinder normally aspirated and supercharged engines is presented.

IOPARDO, Vincent J., Professor, "Study of Gas Turbines Via Computer Modelling," *Proceedings of the Seventeenth Annual Pittsburgh Conference*, Instrument Society of America, 17 (April 1986), 597-599.

This paper presents a description of a particular design tool developed for the applied thermodynamics course at the U.S. Naval Academy. Specifically, a computer program was formulated which allows the student to study a variety of gas turbine configurations. Not only are the schematics of the various cases available on the graphics terminals, but there is also the option of varying a number of parameters.

MILLER, Myron H., Assistant Professor, co-author, "Basic Concepts in Atomic Emission Spectroscopy," *Inductively Coupled Plasmas in Analytical Atomic Spectrometry*, New York, New York: VCH Publishers, Incorporated, 1987, pp. 15-63.

Emission from spectroscopic plasmas is treated at an introductory level, without undue emphasis on any particular light source. It should be a useful starting point for a spectroscopist interested in investigating inductively coupled plasmas (ICP). Equations are presented without derivation, but generally with discussion of spectrochemical implications or validity ranges. Some typical numerical examples are provided.

MILLER, Myron H., Assistant Professor, co-author, "Thermal Pinch Effect in the Argon D.C. Plasma," *Spectrochimica Acta*, 41B, 5 (1986), 453-467.

Creation and consequences of the marked thermal pinch in the analytical d.c. plasma (DCP) are investigated. The flowing plasma constricts, due to interaction between forced convective cooling and electric current regulation of the low power arc. Distinctive visual, spectroscopic, and operational features of the DCP are associated with the thermal pinch and the transport properties of hot argon. Response of modelled electron density to changes in cooling gas flow rates is compared with experimental data. Implications for non-local thermodynamic equilibrium (LTE) spectrochemical excitation are noted.

ROLFES, Marc H., Lieutenant, USN, *Applied Thermodynamics Laboratory Manual with Computer Applications*. Annapolis, Maryland: United States Naval Academy Press, 1986.

An applied thermodynamics course takes many forms at colleges and universities across the country. At the United States Naval Academy, this course builds on the fundamental concepts learned in the classical thermodynamics course by emphasizing laboratory work, problem solution techniques, and computer analysis. As such, a laboratory manual has been developed which outlines the theoretical and experimental aspects of each of several laboratory exercises. Emphasis has been placed on presenting the fundamentals, thereby allowing the students to formulate and present the specifics of each laboratory in a formal written report. Laboratory exercises include several power cycles, as well as compressible flow, real gas behavior, and heat pump applications. In addition, laboratory work is supplemented by parametric computer analysis and design optimization of these cycles and phenomena.

WU, Chih, Professor, "Probabilistic Modeling and Simulation of Multi-Phase Interface Problems," *International Journal of Modeling and Simulation*, 6, 2 (June 1987), 107-113.

As two rough surfaces approach each other, the in surface asperities begin to contact at a discrete number of points. The real contact area increases as the applied load increases. The degree of contact, which is a strong function of the number and nature of surface asperities, has a significant influence on

the heat conduction behavior across the contacting gap and on the carrying capacity of a lubricated bearing.

This paper presents a stochastic modelling and a finite element formulation, in which effects due to the interference of asperities are included in the form of a truncated normal probability density function. The conventional heat conduction equation and the Reynold's equation of lubrication are modified. The work introduces the finite element method into the realm of stochastic processes, and may help to simulate and resolve such problems as gap heat conduction and film lubrication, where discrete microscopic effects cannot be ignored and where using each finite element as a continuum fails.

Although this paper is limited to gap heat conduction and thin film lubrication, the same concept can be readily generalized to other field problems, such as fluid-fluid interfaces, solid-fluid interaction, etc.

WU, Chih, Professor, co-author, "Modelling and Simulation of a Naval Shipboard Heat Pump," *International Journal of Modeling and Simulation*, 6, 2 (June 1987), 155-163.

A computer simulation model has been developed for a water-to-water heat pump. The simulation model is intended to evaluate the thermal performance of this water-to-water heat pump system. It can also be used as a computer-aided design analysis tool, since it has many built-in design options. The modeling techniques used and the different types of operational modes and component options relevant to shipboard environment are presented.

Presentations

FLEISCHMANN, Shirley T., Assistant Professor, "The Wooden Shoe Regatta, A New Tradition In Learning," Sigma Xi, United States Naval Academy, Annapolis, Maryland, 15 October 1986.

FLEISCHMANN, Shirley T., Assistant Professor, "Teaching and Learning Strategies for Students in the Computer Age," Mathematics Department, United States Naval Academy, Annapolis, Maryland, 7 January 1987.

HASSON, Dennis F., Professor, "Impact Testing," Symposium on Ceramic Composites, American Society for Metals, Materials Week '86, Orlando, Florida, 7 October 1986.

HASSON, Dennis, F., Professor, "Flexure Fatigue of Aramid Reinforced Aluminum 7075-T6 Laminated Composites in Lab and Salt-Contaminated Moist Air," Symposium on Metal Matrix Composites, American Society for Metals, Materials Week '86, Orlando, Florida, 7 October 1986.

HASSON, Dennis, F., Professor, "Impact Testing of Ceramic Matrix Composites," Eleventh Annual Conference on Composites and Advanced Ceramic Materials, American Ceramic Society, Cocoa Beach, Florida, 21 January 1987.

JOYCE, James A., Professor, "J Integral Testing and Applications in Elastic Plastic Fracture," Yugoslavia Fracture Seminar, Dubrovnik, Yugoslavia, 24 June 1986.

JOYCE, James A., Professor, co-author, "Measurement of Dynamic Fracture Toughness of Ductile Materials," American Society for Testing and Materials, Third International Symposium on Non-linear Fracture Mechanics, Knoxville, Tennessee, 6-8 October 1986.

JOYCE, James, A., Professor, co-author, "An Advanced Procedure for J-R Curve Testing Using A Drop Tower," ASTM Third International Symposium on Non-linear Fracture Mechanics, Knoxville, Tennessee, 6-8 October 1986.

JOYCE, James A., Professor, co-author, "Separation of Energies in Elastic-Plastic Fracture," ASTM Third International Symposium on Non-linear Fracture Mechanics, Knoxville, Tennessee, 6-8 October 1986.

JOYCE, James A., Professor, "A Closer Look at Tearing Instability and Arrest," ASTM Third International Symposium on Non-linear Fracture Mechanics, Knoxville, Tennessee, 6-8 October 1986.

JOYCE, James A., Professor, "Dynamic Fracture Testing," David W. Taylor Naval Ship Research and Development Center Code 2814 Branch Meeting, Annapolis, Maryland, 12 November 1986.

KEATING, Eugene L., Professor, co-author, "Octane Insensitivity of Supercharged Internal Combustion Engines Using Chemical-Acoustic Charge Conditioning," Tenth Annual ASME Energy-Sources Technology Conference and Exhibition, Dallas, Texas, 15-18 February 1987.

KEATING, Eugene L., Professor, co-author, "Evidence for Chemical-Acoustic Interaction for Internal Combustion Engines," Twenty-Fourth Aerospace Sciences Meeting, Reno, Nevada, 6-9 January 1986.

LOPARDO, Vincent J., Professor, "Study of Gas Turbines Via Computer Modelling," Seventeenth Annual Conference—Modeling and Simulation, Pittsburgh, Pennsylvania, 24 April 1986.

WU, Chih, and Eugene L. KEATING, Professors, co-authors, "Potential Applications of Liquid Hydrogen to Military Aircrafts," Sixth World Hydrogen Energy Conference, Vienna, Austria, 20-25 July 1986.

WU, Chih, Professor, "Computer-Aided Design of a Thermoelectric Generator," International Modeling and Simulation Conference, Williamsburg, Virginia, 3-5 September 1986.

WU, Chih, Professor, "Evaluation of Refrigerants as Working Fluids for an OTEC System," International Modelling and Simulation Conference, Williamsburg, Virginia, 3-5 September 1986.

WU, Chih, Professor, **"Mathematical Modelling and Computer Simulation of a Tidal Power Plant with Variable Flow Rate,"** Third International Conference on Systems Research Informatics and Cybernetics, Baden-Baden, West Germany, 19-24 August 1986.

WU, Chih, Professor, **"Teaching Long Term Forecasting on Oil Consumption and Production,"** 1986 Chinese American Professionals Association (CAPA) Conference, Gaithersburg, Maryland, 6-7 September 1986.

WU, Chih, Professor, **"Potential Application of CAI in Teaching Chinese for Foreigner Oversea Chinese,"** 1986 Chinese American Professionals Association (CAPA) Conference, Gaithersburg, Maryland, 6-7 September 1986.

WU, Chih, Professor, **"Wind Power Estimation of a Military Wind Turbine by Computer Simulation,"** European Modelling and Simulation Conference, Naples, Italy, 29 September-1 October 1986.

WU, Chih, Professor, **"Computer-Aided Design of A Thermoelectric Cooler,"** International Computer Symposium, Tainan, Taiwan, China, 15 December 1986.

WU, Chih, Professor, **"Computer Program to Simulate the Performance of A Tilt Angle Solar Collector,"** Simulation, Modelling, and Development Conference, Cairo, Egypt, 2-4 March 1987.

WU, Chih, Professor, **"Computer Program to Simulate the Performance of Thermoelectric Devices for Optimum Design,"** Simulation, Modelling, and Development Conference, Cairo, Egypt, 2-4 March 1987.

WU, Chih, Professor, and Paul B. STUMBO, Captain, USAF, **"Long Term Forecasting on Oil Production,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

WU, Chih, Professor, and Claude P. LIM, Midshipman 1/C, **"Performance Simulation of an Endoreversible Heat Engine,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

WU, Chih, Professor, **"Determination of Wind Speed Parameters and Characteristic,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

WU, Chih, Professor, **"The Impact of High Informational Technology on Education in Developing Countries,"** The International Conference on Technology Educational Society: Future Directions, Melbourne, Australia, 10-15 May 1987.

WU, Chih, Professor, **"Potential Application of CAI in China,"** Eighth International Conference on Computers in Chemical Research and Education, Beijing, China, 15-20 June 1987.

Naval Systems Engineering

PROFESSOR RAMESWAR BHATTACHARYYA
CHAIRMAN

The Naval Systems Engineering Department conducted scholarly research and professional development works most vigorously in marine engineering and naval architecture, as well as in ocean engineering during the academic year 1986-1987. Faculty members and midshipmen took part in numerous sponsored and non-sponsored research activities, including the Trident Scholar program. A number of faculty members participated in non-funded research and directed senior level midshipmen in their research activities, utilizing the excellent laboratory and computer facilities available to this department.

At this point it is appropriate to recognize with pride the research accomplishments of Professor Michael E. McCormick, who was selected from the entire U.S. Naval Academy faculty to receive the newly established "Research Excellence Award." This award was given in recognition of research conducted over a period of almost twenty years in such fields as ocean waves, wave energy conversion, off-shore structures, and ocean engineering support platforms.

The Department continued to participate actively in professional society meetings and conferences, both nationally and internationally. Research results have been published in journals and technical publications, or presented at national and international seminars. The outcome of the Department's deep involvement in research by the civilian and military faculty members is reflected in the academic environment in the classroom for professional and major courses.

Research themes of the Department faculty were varied. They included gas turbine exhaust analysis, receiver design of solar collectors, conceptual design



of a semi-submersible platform, neutron shielding studies, computer simulation of underwater breathing apparatus, fuel additives, reliability analysis for marine structures, and Computer-Aided Engineering.

Research funding was made available from many sources including departmental operating funds and contracts and grants from various organizations such as the Naval Academy Research Council, Naval Facilities Engineering Command, Military Sealift Command, Naval Surface Weapons Center, Naval Coastal Systems Center, and David W. Taylor Naval Ship Research and Development Center.

Sponsored Research

Gas Turbine Exhaust Flow Distribution Analysis

RESEARCHERS: LIEUTENANT WAYNE J. HARMAN, USN AND
ASSOCIATE PROFESSOR JOHN E. ALLEN
(AEROSPACE ENGINEERING DEPARTMENT)

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The current Navy in-house activities in the area of gas turbine engine technology development are primarily directed at optimizing and evaluating design projections of the major competitors in the Inter-Cooled-Regenerated (ICR) gas turbine effort. The success of the ICR gas turbine at improving engine performance is predicated on the assumption that the uniform exhaust flow profile is achievable, and the exhaust energy can then be effectively extracted by the regenerator. The actual flow fields in turbine exhaust systems are non-uniform and contain fluctuating disturbances that can severely degrade regenerator performance, as demonstrated

by the difficulties encountered in the RACER program. These flow disturbances need to be studied and measured experimentally to permit proper design of the regenerator. In other words, there is a need for advanced flow diagnostics, computational algorithms, and physical modeling for verification of the next-generation engine designs with the added benefit of earlier identification and evaluation of potential design shortcomings, which will allow significantly more cost effective redesign. The resultant computational codes must be validated before being incorporated into the design process.

A New Receiver Design for Solar Concentrating Collectors

RESEARCHER: ASSISTANT PROFESSOR KEITH W. LINDLER
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

The objective of this research effort is to develop a computer program which can be used to compare the performance of various receiver configurations

in order to determine if the performance improvement obtained by the new receiver can more than offset the cost increase expected for the design.

Conceptual Design of a Modular Semi-Submersible/ Jack-Up Platform

RESEARCHERS: PROFESSOR MICHAEL E. MCCORMICK AND
ASSOCIATE PROFESSOR ROBERT H. MAYER
SPONSOR: NAVAL FACILITIES ENGINEERING COMMAND

This project involved the conceptual design of a modular, semi-submersible jack-up structure for specific use by the Naval Construction Force as a diver-support vessel in offshore construction. The objective of this research effort was to explore existing offshore technology, develop possible structural configurations, and recommend a conceptual design for subsequent hydrodynamic and structural assessment. The recommended platform was to be of modular construction to facilitate assembly at a remote location with limited construction support, was to support varying payloads for different operational requirements, and was to be seaworthy in conditions up to sea-state 6 (in addition to support-

ing certain mission requirements in conditions up to sea-state 4).

The recommended design includes an 80' x 40' operating platform with a 20' x 10' centerwell, supporting buoyancy pontoons, and a jack-up capability to raise the operating deck above the waves during other than operational conditions. The structure is to be composed of modular, pre-fabricated units, available commercially. The cost of fabricating such a platform is assessed at less than \$1,000,000 each.

The proposed design was favorably received by the customer and the researchers were encouraged to pursue hydrodynamic and structural assessments.

14 MeV Neutron Shielding Studies

RESEARCHERS: PROFESSORS MARTIN E. NELSON AND
PETER F. WIGGINS
SPONSOR: NAVAL SURFACE WEAPONS CENTER, WHITE OAK LABORATORY

A new approach is a continuation of the study of the attenuation of NE-213 Detector. Linear attenuation coefficients for 14 MeV neutrons were determined for a variety of shielding materials which are of interest to the U.S. Navy. The system used col-

lects a three-dimensional matrix of neutron and gamma data. After separation, the neutron spectra are binned, and unfolded using a computer code. This leads to the neutron energy spectra, kerma, and finally to the linear attenuation coefficient.

Computer Simulation of Underwater Breathing Apparatus

RESEARCHER: ASSISTANT PROFESSOR MARSHALL L. NUCKOLS
SPONSOR: NAVAL COASTAL SYSTEMS CENTER

The coupling of computer simulation methods with an extensive data base of diving hardware characteristics has produced a new tool for the analysis and design of underwater breathing systems. This system simulator makes possible the modular "construction" of any conceivable breathing gas system from a bank of computer memory-resident components. The simulator can be exercised to predict the behavior of conceptualized systems when conjoined with a man working and breathing within a use-

specified range of underwater environmental conditions. By allowing "what if" type design questions and economical parametric analyses on design options, the simulation model significantly reduces the cost and time required for the development of a new diving system; drastically reduces the testing required in the development and modification phases of new and existing systems; and provides a diagnostic tool to investigate potential safety hazard scenarios.

Fuel Additives Study

RESEARCHER: ASSISTANT PROFESSOR KENNETH L. TUTTLE
SPONSOR: MILITARY SEALIFT COMMAND

The objective of this research was to evaluate three different fuel additives for possible use on Military Sealift Command ships. The study included tests and analysis of these additives for effectiveness and substantiation of manufacturers' claims, and ship

visits to observe results first hand. The results were to dismiss one additive as unsatisfactory, to discourage use of a second, and finally to recommend use of the third additive.

Reliability Analysis of Ship Structures in a Seaway

RESEARCHER: ASSISTANT PROFESSOR GREGORY J. WHITE
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

In the continuing effort to apply reliability methods to marine structures, the next logical step is to include these techniques in the design process, thereby allowing the design of more efficient structures with some measure of certainty of the reliability level involved. The particular application in ship structural design which would benefit the most from using reliability methods is the design against fatigue failure.

In this study, some of the reliability-based methods currently being used (or proposed for use) in the design of structures against fatigue are examined. Each is evaluated as to its suitability for use in the structural design of ships. In addition, the researcher proposes a recently introduced

new reliability-based fatigue design format, which is based on the recently introduced Reliability-Conditioned (RC) design method and the Load and Resistance Factor Design (LRFD) code format. This approach should provide the design engineer with an easy-to-understand-and-use tool based on the LRFD format. The RC method will enable him quickly and accurately to design the components of a ship's structure such that a desired level of safety against fatigue is achieved.

Each of the methods discussed is used to solve a practical example. The results of that example and several others are used to discuss the relative merits of each method.

A Trade-Off Study of Sonar Performance and Powering Requirements for Unconventional Sonar Domes

RESEARCHER: MIDSHIPMAN 1/C JENNIFER CULBERTSON
ADVISER: PROFESSOR BRUCE JOHNSON
SPONSOR: TRIDENT SCHOLAR PROGRAM

The results of an investigation of the resistance characteristics and powering requirements of unconventional sonar domes are presented and discussed. The sonar dome designs evaluated were below-baseline domes incorporating long prismatic sections designed to house large planar passive arrays. The cross-sectional area and the longitudinal length of the domes were systematically varied. The predicted powering requirements for a parent destroyer hull form appended with different designs of sonar domes were compared to the relative improvements in sonar capabilities that each dome design could offer. These changes in powering requirements were translated into fuel costs to provide a basis for an economic trade-off analysis.

Hull form design was done with Fastship computer-aided inter-active software available at the U.S. Naval Academy's Hydromechanics Laboratory. Powering predictions were made by using the Ship Resistance Prediction Method flow code numerically to evaluate wave resistance. The results from this investigation follow trends similar to recent series studies of above-baseline bow bulbs. If the U.S. Navy places priority on improving its hull mounted sonars, then the economic trade-off for using a large, unconventional sonar dome warrants further investigation.

Development of a Tissue Equivalent Proportional Counter System for Measurements of Neutron Dose

RESEARCHER: MIDSHIPMAN J. C. ROGER J. HILARIDES

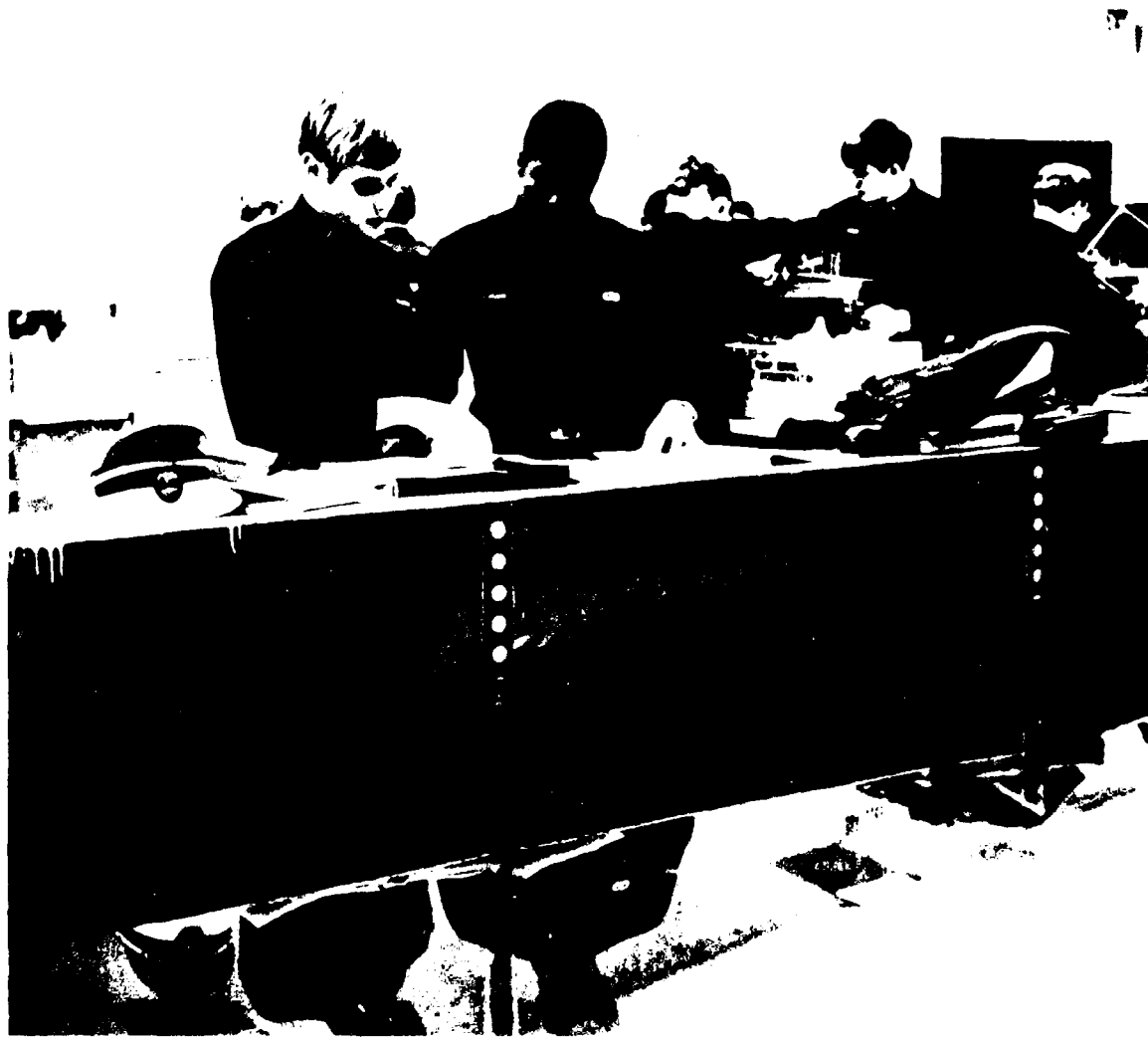
ADVISER: PROFESSOR MARTIN E. NELSON

SPONSOR: TRIDENT SCHOLAR PROGRAM

The purpose of this project was to develop and test a working Tissue Equivalent Proportional Counter (TEPC) system to utilize a personal computer work station and a spreadsheet program for data analysis and to compare the response of the TEPC to the thermoluminescent dosimeter (TLD), AN PDR 70, and NE 213.

A literature search produced specific information on previous work done with the TEPC. This information provided a foundation for the varied analysis done using the TEPC. The analysis and comparisons were completed using the Naval

Academy's Calitrium 252 Plutonium Beryllium and 14 MeV neutron sources. The TEPC analysis provided the following dose parameters: linear energy, absorbed dose, quality factor, and dose equivalent. Use of the personal computer work station allowed for quick and efficient data handling, thorough data analysis, and graphics capabilities. Comparison were made using the TEPC, and it was found that the TEPC response was valid for medium and high energy neutrons. The results of this study indicate that serious consideration should be given to the use of the TEPC as an area dosimeter.



Independent Research

Computer-Aided Engineering

RESEARCHER: ASSOCIATE PROFESSOR THOMAS J. LANGAN

The purpose of this research is to develop software and methods to aid engineers in the design and manufacture of rotary equipment, such as turbines, compressors, and propellers. The work is being carried on in two phases. In phase one, electronic spreadsheets are being developed as design tools,

and the output is transferred to the VAX in CADIG to develop tapes to control the machine tools for manufacturing. The second phase is to develop an extensive suit of programs for interactive design on the VAX.



Research Course Projects

Kerosene Heater Wicking Study

RESEARCHER: MIDSHIPMAN 1 C MARK A. BELCHER

ADVISER: ASSOCIATE PROFESSOR CLYDE C. RICHARD

The objective of this project is to determine the effects of varying temperature gradients on the performance of kerosene space heaters, with particular focus on the wick and the wicking process. It is suspected that increasing fuel temperature speeds up the fuel transfer process in the wick, thereby increasing burn rate and flame size. This results in still higher fuel temperatures, leading to an upward spiral effect, possibly ending in large fires or explosions. This project is designed to confirm or disprove this

theory. It involves experiments using a standard Yursa J-50 two-foot cylindrical space heater, fueled by kerosene. The experiments were run by varying the wick height, while increasing the weight of the fuel consumed over a given time period and noting the height of the flame. The experiments then were run for the same parameters, but with the fuel pan heated. Thermocouples positioned strategically on the heater are used to determine the temperature distribution.

Stability Study of a Diver Support Platform Design

RESEARCHERS: MIDSHIPMEN 1 C MATTHEW S. BLISS AND
MATTHEW L. EARLY

ADVISER: PROFESSOR MICHAEL E. MCCORMICK

A conceptual design of a diver support platform (DSP) has been conceived by Dr. M. E. McCormick and Dr. R. H. Mayer for the Naval Facilities Engineering Command (NAVFAC). The DSP is a combined semi-submergence/jack-up floating platform. Static and dynamic stabilities of the DSP are most

important aspects of the design, since instabilities in seas up to sea-state 6 can affect both performance and safety. In this study, static and dynamic stability calculations were performed. Validity of these calculations were tested on a one-twentieth (1/20th) scale model in the wave and towing tank.

Methods of Radon Detection

RESEARCHER: MIDSHIPMAN 1 C ANDREW D. BUCKON

ADVISER: PROFESSOR MARTIN E. NELSON

The purpose of this research is to determine the amount of radon gas present in an environment by using two different methods. The first method involves the use of an activated charcoal canister which absorbs the radon gas. A method of calibration was then calculated to determine the amount of radon present by measuring gamma radiation

emitted by radon daughter isotopes. The second method involves the passing of air through a filter paper which collects alpha particles emitted by radon decay. Using the alpha spectrometer, a correlation can then be determined to relate the number of alpha particles to the radon gas concentration.

Design of a McCabe Wave Pump for Operation in the Chesapeake Bay

RESEARCHER: MIDSHIPMAN 1 C GREGORY S. COIL

ADVISER: PROFESSOR MICHAEL E. MCCORMICK

A reverse osmosis desalination system required a pressure source for pushing the working substance (salt water) through the desalination membrane. The purpose of this project is to design a McCabe Wave Pump capable of sustaining 1200 psi in the Chesapeake Bay region, using commercial materials available for use in a desalination system. The constrictions on this project are the wave height and period and the depth of water available, due to water-borne traffic. A McCabe Wave Pump was designed using two blunt-ended boat hulls, pistons, and rods avail-

able commercially, along with common materials such as plates of steel. Since 100% overdesign is used, this system is predicted to be able to maintain the 1200 psi limit and still operate successfully in the Chesapeake Bay region. The usefulness of a desalination system powered by wave energy is readily apparent in consideration of the many islands in the world without their own source of fresh water. Such a system would also be valuable to the Navy for use in similar circumstances.

Neutron Activation Analysis: Gasoline vs. Kerosene in Burned-Out Kerosene Heaters

RESEARCHER: MIDSHIPMAN 1 C ROBERT I. DOUGLASS

ADVISER: ASSOCIATE PROFESSOR CLYDE C. RICHARD

The objective of this project is to determine if, through neutron activation analysis techniques, one can conclusively prove after a portable kerosene heater has been destroyed by fire, whether gasoline or kerosene was used in that heater. The project uses a high-purity germanium coaxial photon detector system, the Canberra Series 35 multichannel analyzer, neutron sources of different energies found in the Academy's nuclear laboratory facilities, the Zenith Model 248 computer, and various gamma energy spectra reference materials. In particular, the researcher was looking for a "fingerprint" of an additive or other material that could be detected in

prepared samples. These samples first consisted of small glass plates that had been soaked in gasoline and kerosene; then these substances were boiled off as would happen in a fire. The final goal was to determine from small sections cut from the burned out fuel tanks of two kerosene heaters, which was destroyed by gasoline, and which was destroyed by kerosene, to show conclusively which was which. This technique could prove vital in the case of a fire in assessing whether a kerosene heater was poorly engineered, or whether the customer was negligent by using gasoline for fuel.

The Effects of Waves on Transverse Stability

RESEARCHER: MIDSHIPMEN 1 C EVARISTO GONZALEZ

ADVISER: PROFESSOR ROGER H. COMPTON

Adequate stability in all operating conditions is a necessary characteristic of any successful marine vehicle. While classical hydrostatic stability analysis is well understood and religiously applied in any ship design, the more realistic (but far more complex) problem of ship stability in actual operating conditions -- i.e., in waves caused by the ship's own forward speed and waves caused by external phenomena (wind, swell, other ship wakes, etc.) -- is less

well understood or routinely analyzed. The researcher conducted an experimental study of the effects on transverse stability in regular, long-crested, following seas of the 108-yard patrol craft (YP). Effects of wave height in a following sea condition near an encountering frequency of zero for the subject hull with a small initial angle of list and two KG's were investigated.

Limited Input Stability Analysis

RESEARCHER: MIDSHIPMAN 1/C JOHN W. GORDON
ADVISER: ASSOCIATE PROFESSOR BRUCE C. NEHRLING

The objective of this project was to develop a customized, computerized damage stability analysis routine for use on a portable personal computer. The routine which was developed uses a spreadsheet format for data entry and display of results. The program is self-booting and is totally menu-driven. Because the system would be used in a rapidly changing combat environment, minimum input by the operator, along with hardware which is designed to operate without the aid of ship's power, was re-

quired. The bulk of the program's pre-established database consists of the ship's hydrostatic information and internal configuration. Dynamic input is the amount of flooding in a compartment or compartments, whereas the output includes damaged displacement, drafts forward and aft, angle of list, and resulting transverse metacentric height. The program's database may be modified to suit any ship.

A Comparative Study of Testing Methods for Added Resistance Due to Waves

RESEARCHER: MIDSHIPMAN 1/C LOUIS J. GREGUS, JR.
ADVISER: PROFESSOR ROGER H. COMPTON

The results of two different resistance testing methods are presented and discussed. The constant driving force, gravity-tow method is compared to the constant velocity, powered carriage method, which is currently the industry standard. The tests were run in the 120' towing tank at the U.S. Naval Academy's Hydromechanics Laboratory (NAHL). Experimental procedures and computer-based data acquisition and analysis methods at NAHL are described.

The NAHL's model YP81-7 was used for all tests. It is a 1/20 scale representation of the YP 676 class. The model represents the prototype as built, and was ballasted to represent prototype operating conditions.

The model was towed in regular long-crested head seas at 10 knots scale speed. Encounter frequencies ranged from 0.6 Hz to 2.25 Hz. The model was towed both with and without surge freedom to compare the effects of this parameter. The principle of linear superposition was used to calculate the ship response spectrum in fully developed seas at Sea State 5.

The same model was then towed in irregular, long-crested waves corresponding to Sea State 5, using the Gravity Tow Method. Driving forces varied from 2 lbs. to 10 lbs. Results for the two methods differed by an insignificant margin.

Hydrodynamic Resistance of a SCUBA Diver

RESEARCHER: MIDSHIPMAN 1/C ERIC C. HOLLOWAY
ADVISER: ASSISTANT PROFESSOR MARSHALL L. NUCKOLS

The researcher sought to optimize the arrangement of life support equipment in terms of hydrodynamic resistance. Tests performed in the NAHL 120' and 380' towing tanks included an actual diver and a dummy configured as a diver. The dummy was towed to establish uniformity of results compared to

an actual diver. Once this was accomplished, different breathing apparatus were placed on the dummy and the resistance again measured. Data from tests involving several different life support devices were analyzed and an order of merit established.

Maneuverability in Preliminary Ship Design

RESEARCHER: MIDSHIPMAN 1 C ERIC C. HOLLOWAY

ADVISER: PROFESSOR RAMESWAR BHATTACHARYYA

Through the literature, it is found that while many experimental methods for predicting the motions of a ship exist, they are difficult to apply to the early stages of the design process. They are derived from data taken from model tests, and really apply only to the hull form which was tested. Maneuvering variations from one hull form to the next can have a significant impact upon the magnitudes and effects of these forces.

There are several things a designer can do to ensure that his ship will most likely possess desirable maneuvering traits. They involve the size and place-

ment of the rudder, characteristics of the underwater hull form, and the placement and arrangement of the bridge and pilot house. To a large extent, maneuverability in the preliminary stages of ship design is qualitative vice quantitative.

The report contains a computer program capable of utilizing both linear and nonlinear theory to predict the turning path of a ship over time. Two different sets of coefficients are used to predict the path of a typical tanker and a Mariner class vessel. The computer output includes time histories of position and forward velocity.

An Experimental Analysis of the Effects of Pitch Gyradius on Added Ship Resistance in Waves

RESEARCHER: MIDSHIPMAN 1 C THOMAS K. KISS

ADVISER: PROFESSOR ROGER H. COMPTON

A series of model tests was conducted in the Naval Academy's 120-foot towing tank to examine the effects of pitch gyradius on the added ship resistance caused by waves in head seas. Experiments were performed with a 5.5-foot model of the U.S. Coast Guard Cutter HAMILTON. The model was towed over a range of speeds in an irregular, long-crested

wave system corresponding to a ship scale Sea State 5. Additional tests were run in scaled sea states ranging from three to seven, with a constant pitch gyradius, to examine the change in resistance as a function of sea state. The gravity two system was utilized for all tests.

Modeling the Spray Pattern Generated by the YP676 Class Bow

RESEARCHER: MIDSHIPMAN 1 C PETER E. KOWENHOVEN

ADVISER: PROFESSOR ROGER H. COMPTON

The ultimate objective of this study, of which this project is the first step, is to modify the spray pattern generated by the YP676 class bow at higher speeds. In order for modifications to take place efficiently, the existing bow must be lofted and fabricated full scale, to insure similitude of the spray pattern. Before this could be done a number of steps had to be taken.

Through background research and a detailed comparison of stem profiles generated by designer offsets, and "as built" lines, it was concluded that the actual stem profile and bow lines had yet to be determined accurately. To obtain data necessary for defining such lines, YP681 was used to loft water-

planes by means of an apparatus designed and constructed in the Naval Academy's Hydromechanics Laboratory. Full-scale bowlines were developed, along with a stem profile that further verified the inconsistencies in the previous data.

A wood foam model was constructed. That model includes the bow section between the 4' WL and 11' 4" WL, and from the stem to station 12. Due to the time consumed in defining the actual bow shape, modifications could not be included within the scope of this project. Testing of the constructed bow was conducted in the Naval Academy Hydromechanics Laboratory during the summer of 1987.

Wave Groups in Random Seas

RESEARCHER: MIDSHIPMAN 1 C HENRY A. LAIBLE

ADVISER: PROFESSOR THOMAS H. DAWSON

Time history laboratory data of water surface displacement in random waves have been obtained for the purpose of characterizing wave groups, that is, sequences of consecutive high waves. Statistical data have been determined for such parameters as (1)

time between occurrence of groups, (2) time duration of groups, and (3) the number of waves in a group. Results are of interest because of enhanced motions of structures in a seaway that can arise from the "periodic effect" of the wave groups.

Absorption Capability of CO₂ Scrubbers Under Variable Metabolic Loadings

RESEARCHER: MIDSHIPMAN 1 C ROBIN A. YOUNG

ADVISER: ASSISTANT PROFESSOR MARSHALL L. NUCKOLS

The objective of this project is to demonstrate the effects of varying metabolic profiles on the absorption capabilities of a CO₂ canister which "sees" non-cyclic metabolic profiles. Researchers have observed that canisters having low initial metabolic inputs, followed by increased CO₂ loadings, show improved performance over canisters which see high loadings at the beginning of the mission. For this project, CO₂ injection profiles to a CO₂ scrubber design were varied to demonstrate their effect on canister

breakthrough time. All tests were conducted closed circuit and continued until canister effluent levels reached 1% (time to 0.5% effluent was noted also). Other profiles were used, as deemed necessary, during this investigation to quantify further non-cyclic metabolic profiles. Effluent CO₂ levels were constantly monitored on strip chart recorders to allow any signs of canister recovery to be observed. When variable metabolic profiles were used, the researcher attempted to provide prediction capability.



Publications

COMPTON, Roger H., Professor, co-author, "The U.S. Naval Academy's New Yard Patrol Craft from Concept to Delivery," *Naval Engineers Journal*, 99, 1 (January 1987), 37-58.

The design of the new 108-ft Yard Patrol Craft (YPC) for the U.S. Naval Academy is described from its beginning as a senior midshipman design project, through its preliminary and contract design development at the U.S. Navy's small craft design team headquarters, Naval Sea Combat Systems Engineering Station, Norfolk, Virginia (NAVSEACOMBATSYSENGSTA-Norfolk). During preliminary and contract design, the Naval Academy Hydromechanics Laboratory (NAHL) provided experimental data to support NAVSEACOMBATSYSENGSTA-Norfolk's design analyses in powering, seakeeping, and maneuvering. Several tradeoff studies of interest to patrol craft designers are presented. Major events in the detail design and construction of the first boat are described from both the designer's and the shipbuilder's point of view. The launching, builder's, and sea trials of the first boat are described. A modification to provide an oceanographic research capability for the Academy's Oceanography Department is outlined. The model data acquired at NAHL and the full-scale data acquired during sea trials provide an unusual opportunity for correlation analyses for small patrol craft.

COMPTON, Roger H., Professor, "Resistance of a Systematic Series of Semiplaning Transom-stern Hulls," *Marine Technology*, 23, 4 (October 1986), 345-370.

The results of a systematic series of small (5 ft) models of hulls typical of coastal patrol, training, or recreational powerboats are presented and discussed. Hull form parameters studied include length-to-beam ratio, displacement-length ratio, longitudinal position of the center of gravity, and section

shaped third chine or round bilge). The effects of these parameters on the calm-water resistance and running attitude (sinkage and trim) over a range of speeds corresponding to waterline length Froude numbers from 0.10 to 0.60 were investigated in the 120-ft towing tank at the U.S. Naval Academy Hydromechanics Laboratory (NAHL). Experimental procedures and computer-based data acquisition and analysis methods used at NAHL are described. The experimental results, as well as the cross-faired and non-dimensionalized stillwater resistance trends are presented. Comparisons with other resistance prediction methods for hulls of the subject type are made. An example of the application of the resistance prediction to the new 108-ft Yard Patrol Craft (YPC) being acquired by the U.S. Naval Academy is included.

DAWSON, Thomas H., Professor, Louise A. WALLENDORF, Ocean Engineer, and John R. HILL, Naval Architect, "Experimental Study of the Relative Motion Morison Equation," *Proceedings of Ocean Structural Dynamics Symposium*, Corvallis, Oregon, September 1986, pp. 666-684.

The applicability of the relative-motion Morison equation in describing laboratory measurements of the displacement and forces on a vertical test cylinder in waves is examined. Results show that this equation, with constant drag, inertia, and added mass coefficients of 1.2, 1.8, and 1.6, respectively, can provide a good description of experimental measurements for (1) the case where the cylinder is fixed against any motion, (2) the case where it is experiencing free damped vibration in still water, and (3) the case where it is experiencing forced steady-state motion in waves. The maximum Reynolds number for the tests was in the range of 10^4 and the maximum Keulegan-Carpenter number was 50.

JOHNSON, Bruce, Professor and Bruce C. NEHRING, Associate Professor, "A Bulbous Bow Methodology for High-Speed Ships," *Transactions of the Society of Naval Architects and Marine Engineers*, New York, New York, November 1986, pp. 31-56.

A methodology for designing a bulbous bow for high speed, fine-form ships is proposed. Using the Kracht bulbous bow design curves developed for low-speed, full-form ships as a starting point, a series of bulb forms is developed and analyzed using a combined numerical and experimental approach to ascertain resistance and seakeeping characteristics. This study was performed using the FFG-7 class of naval frigates as the reference hull form. Nine variations in bulb design (including one similar to that found on the Italian frigate MAESTRALE), plus the bulbous hull form, were analyzed using the David W. Taylor Naval Ship Research and Development Centers XYZ Free Surface Program. Five of the bulb variations were appended to a model of the FFG-7 and tested in the 116-m (380-ft) towing tank at the U.S. Naval Academy. The results from the computer predictions and the calm-watertowing tank tests show remarkably similar trends, while the relative rankings of the bulb forms derived from these analysis procedures were identical. Furthermore, the addition of a bulbous bow to the FFG-7 hull form appeared to degrade only marginally the ship's seakeeping characteristics.

McCORMICK, Michael E., Professor, "Ocean Wave Energy Conversion," *Sea Technology*, 27, 6 (June 1987), 32-34.

A history of wave energy conversion is presented and, in addition, a discussion and description of the advances in the most feasible of systems—the pneumatic system. This system incorporates a turbine which is excited by wave-induced air motions within a capture chamber. There are three turbine designs which are now used: the Wells turbine (a single-rotor bi-directional turbine), the McCormick turbine (a counter-rotating bi-directional turbine), and a uni-directional impulse turbine with rectifying valves. All three systems completed full-scale sea trials in the Sea of Japan in 1986. Results of the sea

trials were very encouraging in that the feasibility of pneumatic wave energy conversion was shown to be a reality.

McCORMICK, Michael E., Professor, co-author, "A Comparative Study of Two Capture Chamber Geometries," *Proceedings of Utilization of Ocean Waves Symposium (American Society of Civil Engineers)*, LaJolla, California, June 1986, pp. D1-D14.

Results of an experimental study of two capture chambers are presented. The capture chamber geometries are those that have been either used or recommended in conjunction with pneumatic wave energy conversion. The respective waterplanes of the chambers are square and circular, and the areas of each are equal. The pressure of the entrapped air above the internal water surface is measured for a series of wave frequencies and heights. The pressure values are then used to determine the potential energy of the compressed air.

For each of three inlet areas of the chambers, the square waterplane chamber is shown to be a more effective energy storer. The reason for this is that the circular chamber is a better radiator. The peak energy storage efficiency of the square chamber is approximately 60%, while that of the circular chamber is 20%. Inlet losses due to the non-streamlined inlet sides are small and, therefore, not responsible for the low efficiency values.

McCORMICK, Michael E., Professor, co-author, "Wave-Induced Orifice Flows," *Proceedings of American Towing Tank Conference*, Washington, DC, August 1986, Section 2, Paper 2.

A vertical oscillating water column with orifice plates over the air chamber above the column is studied both theoretically and experimentally. The orifice plates simulate a wave energy turbine in energy conversion. Results show that the assumption of linear compressibility overestimates the spring effect. In addition, the unsteady orifice damping is found to be far greater than the steady damping. Finally, impedance matching is approximately achieved.

McCORMICK, Michael E., Professor, "**McCabe Wave Pump Desalination System Design**," Division of Engineering and Weapons Report EW-17-86, May 1986.

An analysis of a McCabe Wave Pump (MWP) applied to reverse-osmotic (RO) salt water desalination is presented. Results of the analysis are used to obtain curves for the system dimensions. The operational spectrum of the system is from wave following periods to the resonant period. A design pump pressure of 700 psi is used in order to maintain a near-continuous operational pressure above the steady RO design pressure. Flow rates are also predicted for the system.

McCORMICK, Michael E., Professor, "**Hydrodynamics Coefficients of a Monolithic Circular Off-shore Structure**," Division of Engineering and Weapons Report EW-18-86, November 1986.

Expressions for both the inertial and radiation damping coefficients for a circular cross-sectioned monolithic tower are theoretically derived. In the general analysis the radius matches the fluid velocity obtained from the potential theory with the motions of the structure, the latter assumed to be in a vertical plane. The analysis is then applied to a tower of uniform radius. Following this analysis, the uniform radius tower is then assumed to be composed of elements similar to those used in a lumped-mass structural motion analysis. The added-mass and radiation damping coefficients for three structural elements are determined. The results obtained from the two analyses show that the added-mass is a result of two generated wave systems, one traveling and the other standing. The standing wave system's contribution vanishes in the long wave limit, while the traveling wave contribution vanishes in the

short wave limit. The radiation damping coefficient, due to the traveling wave only, vanishes in both wave limits. Finally, in the long wave limit the predicted added-mass is found to be identical with that predicted for vibrations of a circular cylinder in an unbounded fluid.

McCORMICK, Michael E., Professor, "**An Analysis of an Oscillating Water Column Using the Wave-Maker Theory**," Division of Engineering and Weapons Report EW-33-86, December 1986.

A two-dimensional theory of an oscillating water column wave energy conversion system is presented. The wave-maker theory, as described by Dean and Dalrymple (1984), is used to determine both the added-mass and radiation damping coefficient expressions. The theory is applied to a hypothetical front-facing system resting on the bed. Results of the application show that there are a number of peaks in the extracted power curve (power versus wave period). The highest (or major) peak occurs at rather high period values — those corresponding to the swell. The lower (or minor) peak occurs at the natural frequency of the system, i.e., the natural frequency of the water column acting as a floating body. Tuning is possible to the long, high energy waves by using a movable bulkhead as a backwall of the capture chamber.

The hypothetical system studied is assumed to operate in an impedance-matched condition for optimal performance. For the system chosen, operating in waves having a one-meter height, the peak bus-bar efficiency is predicted to be 18%. This peak efficiency is increased, however, to a value of 33% by doubling the capture chamber length. Higher efficiencies can be achieved by further increasing this length. Thus, the system is shown to be very practical in regular waves.

NELSON, Martin E., Professor, co-author, "Performing Power Plant Reliability Analysis with GADS DATA on a Personal Computer," *Proceedings of the North American Reliability Councils Generating Availability Data System Computer Users Workshop*, Savannah, Georgia, 13-14 August 1987, pp. 1-11.

This paper describes how historical event and period data as collected and reported to the Generating Availability Data System (GADS) can be used on a personal computer to perform power plant reliability analysis. To perform the analysis, a data base must be created in the program. The data base needs to consist of an element list, historical outage, and derate data from one or more units, and unit performance data. The element list can be based on the NERC, EEL, or a utility's own cause code scheme. GADS data issued to establish the historical data base. This data can be entered with floppy disks obtained from NERC or manually. The data bases can be continually updated as future plant equipment failures and events are reported. In use, the program presents a series of menus on the computer monitor, which provides the user with different analysis options. User options include generating component reliability parameters (i.e., meantime-to-event and equivalent meantime-to-restore), data base listings, and improvement project evaluations, as well as other choices. The output is linked to a spreadsheet program, which allows the user to perform further analysis or to display results in a graphical form. An ad-hoc option is also included, which allows the user to generate specific reports from data base searches from among over 100 different fields stored by the program.

NELSON, Martin E., Professor, co-author, "Measurement of Neutron Gamma Dose with a Tissue Equivalent Proportional Counter System," *Proceedings of the Southeast Health Physics Society*, Williamsburg, Virginia, 7 May 1987, pp. 1-21.

This paper describes a neutron-gamma dose measurement system utilizing a Tissue Equivalent Proportional Counter (TEPC). In contrast to Brackenbush, a multichannel analyzer acquires the data and sends it to a personal computer for analysis on a spreadsheet. The system yields information on absorbed dose, lineal energy, quality factor, and dose equivalent for different neutron-gamma sources. Results are presented which compare the response of the TEPC system to a liquid scintillator (NE-213),

neutron remmeter (Snoopy), and a thermoluminescent detector (TLD), with exposure to Californium, Plutonium-Beryllium and 14 MeV neutron sources. Quality factor comparisons are shown between the TEPC system, which measures lineal energy and presently accepted quality factors, which are based on linear energy.

NUCKOLS, Marshall L., Assistant Professor, "Life Support Maintenance for Deep Sea Diving," *Proceedings of the 1987 Annual Meeting of the American Nuclear Society*, Dallas, Texas, 54 (June 1987), 29.

A treatise on life support maintenance in diving for the retrieval of submerged radioactively contaminated materials should include discussions of gas supply requirements, carbon dioxide removal techniques, thermal protection, humidity control, and power sources. For the sake of brevity, this paper highlights only those areas peculiar to deep sea diving, and introduces a design aid being used in the development of new diving life support systems.

NUCKOLS, Marshall L., Assistant Professor, "Optimization of Small Gas Ejectors Used in Semi-Closed Circuit Breathing Apparatus," *Proceedings of the Tenth Annual Energy-Sources Technology Conference*, Dallas, Texas, February 1987, pp. 87-90.

Small gas ejectors, often called jet pumps, are presently being used in semi-closed circuit, underwater breathing apparatus (UBA's), by the U.S. Navy diving community. A recent investigation has proven the feasibility of improving the efficiency of these ejectors by minimizing the ratio of injected gas mass m to the resulting recirculated gas mass M . The effect of this improvement has been to increase the duration of existing makeup gas supply bottles while maintaining satisfactory gas circulation within the UBA.

Significant findings in this investigation are:

- (1) ejector efficiency is relatively insensitive to injected gas pressure,
- (2) an improvement in ejector efficiency can be realized if the system pressure drop in the UBA is minimized, and
- (3) the most significant improvement in ejector efficiency can be realized by properly selecting the ejector nozzle area, a , and barrel area, A . Bottle durations are shown potentially to double when the proper ratio of A/a is chosen.

NUCKOLS, Marshall L., Assistant Professor, "Simulation of a Conceptual Closed-Circuit Underwater Breathing Apparatus," *Proceedings of the Tenth Annual Energy-Sources Technology Conference*, Dallas, Texas, February 1987, pp. 79-86.

Using computer simulation techniques, the breathing dynamics of a closed-circuit underwater breathing apparatus (UBA) consisting of a mask, two breathing bags, and a carbon dioxide absorbent canister with membrane filter are investigated. The effect of varying canister filter resistance, inlet and exit valve areas in the mask, and initial bag volume on the systems breathing characteristics are shown. A decrease in filter resistance is shown to create lag between the two breathing bags to the point that a rapid change in system pressure between end exhalation and begin inhalation occurs, increasing the work of breathing almost four-fold. The initial volume of the breathing bags is shown to be most efficient at twenty-five percent full. Completely filling or emptying the bags initially results in an increase in peak-to-peak pressures, and consequently in diver work of breathing. Decreasing the mask mushroom valve effective areas by half results in a three-fold increase in diver work of breathing.

NUCKOLS, Marshall L., Assistant Professor, "Analysis Efforts for the Conventional Dive System, Vol. I," Division of Engineering and Weapons Report EW-22-86, August 1986.

As part of the initial development of the U.S. Navy Conventional Diving System (CDS), analytical efforts were made to:

- (1) design a lithium hydroxide scrubber using computer modeling techniques,
- (2) size all breathing loop components, and
- (3) generate predicted performances for breathing resistance, work of breathing, and CO₂ absorbent canister durations.

NUCKOLS, Marshall L., Assistant Professor, "Analysis Efforts for the Conventional Dive System, Vol. II," Division of Engineering and Weapons Report EW-23-86, August 1986.

As part of the continued development of the U.S. Navy Conventional Diving System (CDS), potential design problems and recommended design alternatives were proposed. Canister duration tests are evaluated, quality control requirements for LiOH are identified, and optional emergency "come home" capabilities for the CDS are investigated.

TUTTLE, Kenneth L., Assistant Professor, and Shirley T. FLEISCHMANN, Assistant Professor (Mechanical Engineering), "Fuel Additive Review Study," Report to Military Sealift Command, U.S. Naval Academy, Annapolis, 1985.

Fuel additives may be used to combat the effects of impurities in the fuel used on board ship. Sulfur, vanadium, and sodium are the most problematic impurities. Tests have been in progress for several years on several MSC ships to determine the effects of commercially available fuel additives on the samples of fuel and ash deposits taken. The ships' crews were interviewed for background on their operating experience using a fuel additive.

Two additives, Drew Metonate and Ferrous FE-4, were found to be effective in keeping deposits dry, dusty, and easily removed. A third additive, Hot-fert Fire-Bright, in a water emulsification process which was disliked by the crew members, could not be kept in operation, and therefore cannot be expected to save more energy than it consumes.

One of the additives, Metonate, is recommended for expanding use. Ferrous FE-4 is recommended for continued use and further analysis prior to expanding use.

WHITE, Gregory J., Assistant Professor, co-author, "Reliability-Conditioned Partial Safety Factors," *Journal of Structural Engineering*, 113, 2 (February 1987), 279-294.

The first-order second-moment (FOSM) method and the advanced second-moment (ASM) method are used to determine partial safety factors. Design formats based on these methods may result in engineering designs with reliability levels that are different from the ones specified in developing the design formats. The FOSM and ASM methods are evaluated in this paper, and a reliability-conditioned (RC) method is proposed. The proposed method overcomes the shortcomings of the FOSM and ASM methods, and is believed to result in partial safety factors which give engineering design reliability levels equal to the specified ones. The calibration of existing codes can be accomplished easily by determining the safety levels of the current designs first, and then figuring the required partial safety factors for the new design format to give the same safety levels.

WHITE, Gregory L., Assistant Professor, co-author, "Reliability-Based Design Format for Marine Structures," *Journal of Ship Research*, 31, 1 (March 1987), 60-69.

Recently there has been increased effort by classification societies and design authorities to bring reliability analysis into the design process. Typically, these efforts involve using some reliability analysis method to calculate "partial safety factors" for design equations. The mean-value first-order second-moment method (MVFOSM), the advanced second-moment method (ASM), and an "exact" method have been used, or are being proposed for use, in the design of marine structures. In some recent work it has been shown that design formats based on the first two methods may result in engineering designs of different reliability levels than the ones specified in developing the design formats. These three methods are evaluated and a "reliability-conditioned" (RC) method is proposed in this paper. The proposed method overcomes the shortcomings of the MVFOSM and ASM methods and extends the concepts of the "exact" method in a more useful form to handle general types of problems. The RC method is believed to result in partial safety factors which give engineering designs of reliability levels equal to the specified ones.

WHITE, Gregory L., Assistant Professor, co-author, "Reliability-Based Fatigue Design of Ship Structures," *Naval Engineers Journal*, 90, 3 (May 1987), 135-149.

In the continuing effort to apply reliability methods to marine structures, the next logical step is to include these techniques in the design process. The advantage of doing this would be the ability to design more efficient structures with some measure of certainty of the reliability level involved. The particular application in ship structural design that would benefit the most from using reliability method, is the design against fatigue failure.

In this paper, some of the reliability-based methods currently being used (or proposed for use) in the design of structures against fatigue are examined. Each is evaluated as to its suitability for use

in the structural design of ships. In addition, the authors propose a new reliability-based fatigue design format, which is based on their recently introduced Reliability-Conditioned (RC) design method and the Load and Resistance Factor Design (LRFD) code format. This approach should provide the design engineer with an easy-to-understand-and-use tool based on the LRFD format. The RC method will enable him quickly and accurately to design the components of a ship's structure with level of safety against fatigue achieved.

Each of the methods discussed is used to solve a practical example. The results of that example and several others are used to discuss the relative merits of each method.

WIGGINS, Peter E., Professor, co-author, "University Papers in American Nuclear Society (ANS) Transportation with Enrollments and Degrees - III," *Transactions of American Nuclear Society*, 53 (1986), 64.

Statistics on Nuclear Engineering course offerings, enrollment, degrees, and papers published in the American Nuclear Society (ANS) were presented. Trends in enrollment in BS, MS, and Ph.D. students were noted, as well as the increase in foreign students enrolled.

WIGGINS, Peter E., Professor, co-author, "Coal Analysis with Gamma Rays from Capture of ^{252}Cf Neutrons - Experimental Equipment Design and Results," *Nuclear Technology*, 77, 1 (April 1987), 68.

Assemblies have been built for measuring gamma rays from coal following the capture of neutrons from ^{252}Cf . Sources of sizes to 60 μg of calcium $1.4 \times 10^8 \text{ n/s}$ were used. Paraffin moderated the fast neutrons, and beryllium metal was useful as a reflector. The gamma-ray spectrum from a Ge(Li) detector showed that the line intensities of a number of elements (e.g., hydrogen, iron, sulfur, and silicon) could be used to determine concentrations. The aim was to explore possible application in planned coal conversion plants.

Presentations

IERCHBACKER, Alan B., Lieutenant Commander, USN. "Challenger Space Shuttle Recovery Operations," Naval Space Command, Dahlgren, Virginia, 25 October 1986.

LINDLER, Keith W., Assistant Professor, "A New Receiver Design for Solar Concentrating Collectors," ASME ISME-ISES Solar Energy Conference, Honolulu, Hawaii, 23 March 1987.

MAYER, Robert H., Jr., Associate Professor, "Preliminary Design and Construction Plan for a Wave Energy Conversion System," American Society of Civil Engineers Specialty Conference on Ocean Wave Energy Utilization, San Diego, California, 16-17 June 1986.

McCORMICK, Michael E., Professor, "Ocean Engineering Mechanics," Six Seminar Talks, The Johns Hopkins University, Baltimore, Maryland, October and December 1986.

McCORMICK, Michael E., Professor, "Coastal Engineering," Four Seminar Talks, The Johns Hopkins University, Baltimore, Maryland, April 1987.

NEHRLING, Bruce C., Associate Professor, "Stability and Extraction of Grounded Icebreakers," Third International Conference on Stability of Ships and Ocean Vehicles, Gdansk, Poland, 22-26 September 1986.

NEHRLING, Bruce C., Associate Professor, "A Bulbous Bow Design Methodology for High-Speed Ships," Annual Meeting of the Society of Naval Architects and Marine Engineers, New York, New York, 20-21 November 1986.

NUCKOLS, Marshall L., Assistant Professor, "Optimization of Small Gas Ejectors Used in Semi-

Closed Circuit Breathing Apparatus," Tenth Annual Energy-Sources Technology Conference, Dallas, Texas, 18 February 1987.

NUCKOLS, Marshall L., Assistant Professor, "Life Support Maintenance for Deep Sea Diving," 1987 Annual Meeting of American Nuclear Society, Dallas, Texas, 7-11 June 1987.

RICHARD, Clyde C., Associate Professor, "The Lawyer and the Engineer," Defense Research Institute, New York, New York, 11-12 December 1986.

TUTTLE, Kenneth L., Assistant Professor, "Conceptual Design of a Waste-to-Energy Facility," McCormick and Company, Hunt Valley, Maryland, 31 October 1986.

WHITE, Gregory J., Assistant Professor, "Partial Safety Factors for Pressure Vessels," 1986 American Society of Mechanical Engineers Pressure Vessel and Piping Conference, Chicago, Illinois, 21 July 1986.

WHITE, Gregory J., Assistant Professor, "A Reliability-Conditioned Approach for Calibrating Structural Codes," 1986 American Society of Civil Engineers Structures Congress, New Orleans, Louisiana, 17 September 1986.

WHITE, Gregory J., Assistant Professor, "Reliability-Based Fatigue Design of Ship Structures," 1987 American Society of Naval Engineers - ASNE Day, Washington, DC, 1 May 1987.

WIGGINS, Peter E., Professor, "University Papers in American Nuclear Society (ANS) Transactions with Enrollment and Degrees - III," 1986 Winter Meeting of the American Nuclear Society, Washington, DC, 16-20 November 1986.

Weapons and Systems Engineering

PROFESSOR CHARLES E. OLSEN
CHAIRMAN

Research within the Weapons and Systems Engineering Department provided the faculty an environment for continued professional growth and the opportunity to remain current in today's rapidly advancing systems technology. Additionally, every graduating Systems Engineering major participated in independent research, design, and development projects which reinforced the essential interface between academics and practical application.

Every faculty member, both civilian and military, participated in independent research directed at solving current U.S. Navy problems or in support of the midshipmen research programs. Faculty research areas included artificial intelligence, radiation effects on integrated circuits, composite materials, dynamic modeling of gas turbines, magnetostrictive material in control applications, and hypervelocity control problems.

Again this year, emphasis has been placed on the faculty-midshipman relationship during the student independent research course. Each midshipman was assigned both an administrative and a technical adviser. These advisers not only provide support of a technical nature but also emphasize planning, schedule development, and oral and written presentations. Thus, the student is introduced to all aspects of the research process. Typical examples of the forty-eight midshipmen research topics included optical scanning systems, robotic systems, energy control systems, tracking systems, voice recognition systems, and analog and digital control systems.

Funding for research activities has been available from multiple sources including grants and contracts



from various federal agencies and naval laboratories as well as funding support from within the Naval Academy. This year's sponsors included the David W. Taylor Naval Ship Research and Development Center, the Naval Research Laboratory, and the Naval Surface Weapons Center.

Sponsored Research

Tactical Artificial Intelligence Demonstrator (TACAID)

RESEARCHERS: ASSOCIATE PROFESSOR C. GEORGE BROCKUS AND
PROFESSOR PATRICK R. HARRISON, COMPUTER SCIENCE DEPARTMENT
SPONSOR: CHIEF OF NAVAL RESEARCH (OP-98)

TACAID is a derivative of the original Multi-sensor Integration Project started at Naval Research Laboratory in 1984. Building on the experience derived from previous efforts, the researchers focused on the analysis of the functions which seem to be important in a tactical system designed to solve a localization problem. The project explores how Artificial Intelligence can contribute to the solution of such a problem.

As sensors are used to extract current information about the environment, in the presence of noise, the topography of the undersea environment may

be inferred to some degree. It is to be hoped (desired) that the degree can be improved. Currently the target maintains a large advantage in this area.

The problem becomes more severe as parallelism increases. The trend is for that parallelism to increase markedly. Therefore any gains to be made in this area will be very beneficial.

A proposal, resulting from these preliminary studies, to the Center for Applied Research in Artificial Intelligence, Naval Research Laboratory, has won support for this project for the next year.

Radiation Effects Testing of Integrated Circuits

RESEARCHER: ASSOCIATE PROFESSOR ROBERT DeMOYER, JR.
SPONSOR: NAVAL RESEARCH LABORATORY

The object of this continuing research is experimentally to determine the transient and permanent effects of radiation on integrated circuits. Experiments are being conducted to measure both single event upset and total dose effects.

Current efforts are focused upon the develop-

ment of remote computer control techniques designed to control what had been designed as manual test equipment. The result is the ability to observe degradation of test patterns and of memory access times of parts as they are radiated in inaccessible test cells.

Gas Turbine Simulation Using DC Motor

RESEARCHER: PROFESSOR E. EUGENE MITCHELL
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

A current Navy proposal is to supplement (replace onboard auxiliary power systems (for example, diesel powered generators) with variable speed frequency converters, driven from the main propulsion system. The potential savings in diesel fuel could run into the millions of dollars.

A system of this type does not exist, and hence both a detailed computer simulation and hardware prototype are required. The Modeling and Simulation Laboratory (MSL) at David W. Taylor Naval Ship Research and Development Center has the

modeling and simulation task and the majority of the hardware prototype task.

The present role of this research is designing a control system around an 800 Hp DC motor so that the input/output characteristics of the motor-control system are the same as the input/output characteristics of a gas turbine. (for instance, the Allison 501). Once the above step has been accomplished, a further modification is required so that the system simulates one of several different gas turbines.

Magnetostrictive Material in Control Applications

RESEARCHER: VISITING PROFESSOR ROBERT S. REED

SPONSOR: NAVAL SURFACE WEAPONS CENTER, WHITE OAK LABORATORY

Recent developments in magnetostrictive materials, specifically high displacement lanthanide-iron alloys, indicate that these materials may be useful in a wide range of applications in the area of control actuators. Actuators using these materials are being modeled and studied experimentally in order to evaluate their usefulness in potential application areas. The approach is to develop models of the actuators in different control applications and test and improve these models based on experimental results. Specific applications studied include: no load condition, simple loads which have high spring rates,

and complex loads such as beam structures. The purpose in the last case is ultimately to control the vibrations of the beam. The effort to date has concentrated on fairly linear applications with low magnetic field strengths. Future efforts will include non-linear models of the actuators in applications with low magnetic fields. Efforts to date indicate that the materials are well suited to dynamic control situations and that their behavior, in low magnetic fields, can be adequately modeled using fairly standard methods.

Dynamic Modeling of Recuperated, Variable Area Turbine Nozzle (VATN) Gas Turbines

RESEARCHER: ASSOCIATE PROFESSOR JERRY W. WATTS

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER, ANNAPOLIS LABORATORY

Improving the efficiency of gas turbine engines is a major research goal. A big savings of energy can be realized by putting a heat exchanger in the exhaust (recuperated). Recuperation is especially attractive for free power turbines with variable area turbine nozzles (VATN). VATN is another control input which, with fuel control input, produces a multi-input control system. For shipboard auxiliary supply, the shaft speed is ideally held constant in

the presence of varying loads. This complicated control system is being studied by both vendors and users via the use of computer models. A dynamic model of this recuperated, VATN engine has been developed. Model verification using test stand data is almost complete. When it is complete, the computer model will accurately simulate some of the severe transients which can occur in a shipboard operation.

Failure Modes in Composite Materials

RESEARCHER: MISHIPMAN 1 C DAVID A. ROBINSON

FACULTY ADVISER: ASSOCIATE PROFESSOR OLAF N. RASK

SPONSOR: TRIDENT SCHOLAR PROGRAM

The project involved the study of the failure of carbon epoxy composite structures. It was found that the electrical conductivity of the carbon in the carbon epoxy would indicate interval damage not otherwise detectable. Specimens were tested in tension

and compression. Specimens were fatigued and simply strained to destruction. Fatigue damage was studied with both intact specimens and with specimens with previous damage or with deliberately built-in interval flaws.

Independent Research

Scaling Simultaneous Equations to Improve Conditioning

RESEARCHER: ASSOCIATE PROFESSOR C. GEORGE BROCKUS

The objective of scaling simultaneous equations is to obtain solution estimates with better numerical accuracy. Extra benefits accrue in the determination of controllability and observability, as those determination decisions become better defined with improved sets of Eigenvectors.

Poor conditioning can arise through widely

spread sets of Eigenvalues, or from skewed sets of Eigenvectors. The scaling method improves conditioning for problems of the latter type. The techniques applied in this investigation arose from methods used previously for scaling programs used on analog computers.

Hypervelocity Intercept System

RESEARCHER: ASSOCIATE PROFESSOR JERRY W. WATTS

The project models the components of a generalized hypervelocity collision intercept system, which utilizes unguided or passive terminally guided projectiles fired from a non-inertial platform. Hit envelopes for various scenarios were to be determined. Various control strategies are studied to maximize the performance envelope, and a three-dimensional graphic simulation is developed to demonstrate system dynamics.

System components modelled include the platform, tracking and fire control element, command element, search element, tracker, launcher, projec-

tile, target, and environment. Once a generalized model is developed, modifications can be made to accommodate various configurations of the platform, projectile, target, and environment. For given scenarios the command, tracking, and fire control algorithms are investigated to maximize the engagement envelope. The computer modelling is done on the System Engineering Department's VAX 11 computer. Also available are several three-dimensional graphics packages. The programming is done in FORTRAN.

Design Course Projects

Each Systems Engineering major enrolls in ES402, Systems Engineering Design, the capstone course of the major, during his or her senior year. The student is required to propose, design, construct, test, and evaluate a system of particular interest to individual student researchers. The results of academic year 1986-87 follow.

Professors Charles E. Olsen and E. Eugene Mitchell and Associate Professors Thomas E. Bechert, C. George Brockus, Robert DeMoyer, Terrence E. Dwan, Kenneth A. Knowles, Olat N. Rask, Robert S. Reed, and Jerry W. Watts provided technical and systems design assistance and expertise for the listed design course projects.

Collision Avoidance Cart

MIDSHIPMAN 1 C DANIEL L. BASIL
ADVISER: LIEUTENANT COMMANDER PETER F. COSTE, USN

Programmable Cart

MIDSHIPMAN 1 C JAMES A. BATES
ADVISER: LIEUTENANT COMMANDER HAROLD H. CUMMINGS, USN

Infrared Controlled Cassette Recorder

MIDSHIPMAN 1 C DAVID M. BIDDINGER
ADVISER: LIEUTENANT COMMANDER WESLEY C. STANFIELD, USN

A One Line Copier

MIDSHIPMAN 1 C RUDOLPH CARLSON III
ADVISER: LIEUTENANT COMMANDER JOHN D. OUELLETTE, USN

Ultrasonic Focusing

MIDSHIPMAN 1 C GREGORY V. CONTAOI
ADVISER: LIEUTENANT COMMANDER JOHN H. MCKIM, USN

A Remote Video Camera

MIDSHIPMAN 1 C GREGORY B. COTTEN
ADVISER: LIEUTENANT COMMANDER WESLEY C. STANFIELD, USN

An Ultrasonic Security System

MIDSHIPMAN 1 C MARC H. DALTON
ADVISER: LIEUTENANT DAVID O. DREW, USN

Telescope Controller

MIDSHIPMAN 1 C JEFFREY M. DANILLSON
ADVISER: CAPTAIN GREGORY A. MORRISON, USMC

An Automatic String Tuner

MIDSHIPMAN 1 C GREGORY E. DAWSON
ADVISER: LIEUTENANT COMMANDER JOHN H. MCKIM, USN

Light Tracking Fire Control System

MIDSHIPMAN 1 C ROBERT B. DONOHUE
ADVISER: LIEUTENANT COMMANDER PAUL W. BOBOWIEC, USN

Automatic Missile Jamming

MIDSHIPMAN 1 C JOHN E. DRYER
ADVISER: CAPTAIN GREGORY A. MORRISON, USMC

A Computerized Depth Gauge

MIDSHIPMAN 1 C PAUL A. DUPRE
ADVISER: LIEUTENANT COMMANDER PETER F. COSTE, USN

Graphics Digitizer

MIDSHIPMAN 1 C JOHN H. FICKLE, JR.
ADVISER: LIEUTENANT COMMANDER DAVID S. HILDER, USN

Optical Security System

MIDSHIPMAN 1 C GABRIEL A. GOMEZ
ADVISER: CAPTAIN GREGORY A. MORRISON, USMC

Melody Discriminator

MIDSHIPMAN 1 C JOHN K. GREEN, JR.
ADVISER: LIEUTENANT COMMANDER PETER F. COSTE, USN

Infrared Stereo Control

MIDSHIPMAN 1 C DONALD L. GRIFFIN II
ADVISER: LIEUTENANT COMMANDER THOMAS R. WATT, USN

Directional Antenna System for AM Signals

MIDSHIPMAN 1 C REUBEN D. HART, JR.
ADVISER: LIEUTENANT COMMANDER HAROLD H. CUMMINGS, USN

An Automatic Boiler Control

MIDSHIPMAN 1 C JOHN S. HAYDEN
ADVISER: LIEUTENANT THOMAS R. WATT, USN

Aquarium Control

MIDSHIPMAN 1 C SEAN A. HOLMES
ADVISER: LIEUTENANT COMMANDER PAUL W. BOBOWIEC, USN

Digital Cruise Control

MIDSHIPMAN 1 C THOMAS A. HUBBARD
ADVISER: LIEUTENANT COLONEL DAVID W. DIGGLE, USAF

Laser Scanner

MIDSHIPMAN 1 C JEFFREY T. JENNINGS
ADVISER: LIEUTENANT COMMANDER JOHN F. MORAN, USN

Liquid Measuring Dispenser

MIDSHIPMAN 1 C MARK P. JOSLIN
ADVISER: LIEUTENANT COMMANDER JOHN D. OUELLETTE, USN

Automatic Room Lighting Systems

MIDSHIPMAN 1 C MATTHEW S. KIRK
ADVISER: LIEUTENANT COMMANDER THOMAS R. WATT, USN

Laser Communications

MIDSHIPMAN 1 C EDWARD T. KOVANIC
ADVISER: LIEUTENANT COMMANDER MARTIN J. LEGHART, USN

Infrared Remote Control

MIDSHIPMAN 1/C JOSEPH M. LARA
ADVISER: LIEUTENANT COMMANDER CARL E. WICK, USN

An Automatic Backhoe

MIDSHIPMAN 1 C BRIAN P. MALONEY
ADVISER: LIEUTENANT COMMANDER WESLEY C. STANFIELD, USN

Voice-Activated Robot

MIDSHIPMAN 1 C DAVID R. MARSH
ADVISER: LIEUTENANT COMMANDER CARL E. WICK, USN

Graphic Equalizer

MIDSHIPMAN 1 C WILLIAM P. MATTHES
ADVISER: LIEUTENANT COMMANDER JOHN D. OUELLETTE, USN

Pathfinder Robot

MIDSHIPMAN 1 C ALLEN J. MOSS
ADVISER: CAPTAIN GREGORY A. MORRISON, USMC

Antenna Rotator

MIDSHIPMAN 1 C CRAIG R. OECHSEL
ADVISER: LIEUTENANT COMMANDER MARTIN J. LEGHART, USN

Hexapod Robot

MIDSHIPMAN 1/C ERIC N. PERRECA
ADVISER: LIEUTENANT COMMANDER PAUL W. BOBOWIEC, USN

Optical Position Evaluation

MIDSHIPMAN 1/C GEORGE J. PETERSEN
ADVISER: LIEUTENANT COMMANDER DAVID O. DREW, USN

Camera Position Control

MIDSHIPMAN 1/C JOHN E. PLOURDE
ADVISER: LIEUTENANT COMMANDER HAROLD H. CUMMINGS, USN

Infrared Communications

MIDSHIPMAN 1/C KEVIN M. POTTS
ADVISER: CAPTAIN DAN SIMONS, USMC

An Automatic Volume Control

MIDSHIPMAN 1/C GREGORY J. SARGENT
ADVISER: LIEUTENANT COMMANDER JOHN H. MCKIM, USN

Infrared Tracker

MIDSHIPMAN 1/C SHAWN M. SCHARF
ADVISER: CAPTAIN DAN SIMONS, USMC

Infrared Tracker

MIDSHIPMAN 1/C ROBERT F. SMITH
ADVISER: LIEUTENANT JOSEPH P. GILIO, USN

Heart Rate Treadmill

MIDSHIPMAN 2/C JOHN M. SNIFFEN
ADVISER: LIEUTENANT COMMANDER MARTIN J. LEGHART, USN

Laser Tag

MIDSHIPMAN 1/C GREGORY STEFANON
ADVISER: LIEUTENANT COMMANDER DAVID S. HILDER, USN

Water Gun Fire Control System

MIDSHIPMAN 1/C WENDY I. SULLIVAN
ADVISER: LIEUTENANT COMMANDER CARL E. WICK, USN

Morse Code Analyzer

MIDSHIPMAN 1/C STEPHEN M. TEEPLE
ADVISER: LIEUTENANT COMMANDER DAVID S. HILDER, USN

Radio Signal Tracking

MIDSHIPMAN 1/C GREGORY S. THOMPSON
ADVISER: LIEUTENANT COLONEL DAVID W. DIGGLE, USAF

Stabilized Helicopter Landing Platform

MIDSHIPMAN 1/C EBER L. VERHOVSEK
ADVISER: LIEUTENANT COMMANDER DAVID O. DREW, USN

Car Climate Control

MIDSHIPMAN 1/C THOMAS VON KOLNITZ
ADVISER: LIEUTENANT COMMANDER DAVID W. DIGGLE, USAF

A Mobile Robot Arm

MIDSHIPMAN 1/C JOHN C. WILSON
ADVISER: LIEUTENANT COMMANDER JOHN F. MORAN, USN

Automatic Heat and Air Control

MIDSHIPMAN 1/C SCOTT M. WOLFE
ADVISER: LIEUTENANT COMMANDER DAVE S. HILDER, USN

Biofeedback System

MIDSHIPMAN 1/C JASON D. WONG
ADVISER: CAPTAIN DAN SIMONS, USMC

Magnetostrictive Actuator

MIDSHIPMAN 1/C RONALD F. WOODAMAN
ADVISER: LIEUTENANT COMMANDER JOHN F. MORAN, USN

Publications

DeMOYER, Robert, Jr., Associate Professor, co-author, "Application of Measurement Simulation and Least Squares Parameter Estimation in an Undergraduate Servomotor Lab," *IEEE Transactions on Education*, E-29, 3 (August 1986), 142-149.

Laboratory confirmation of theoretical results is important for student confidence in both analytical and experimental techniques. A frequent source of difficulty in obtaining such a confirmation is the improper handling of error-corrupted measurements. This paper discusses measurement simulation and least squares parameter estimation as applied in a DC servomotor laboratory.

Simulation illustrates how ideal measurements are obscured by noise, and parameters are estimated by the use of linear least squares. Motor time constant is estimated by the method of quasi-linearization combined with least squares. Applications of estimation statistics are described.

All measurement and estimation simulations are demonstrated graphically by plots showing both point of measured values and the least squares curve fits.

KNOWLES, Kenneth A., Associate Professor, "Robotics at the United States Naval Academy," *CoED JOURNAL*, VI, 3 (July-September 1986), 35-37.

The history of robotics at the U.S. Naval Academy is described. The development and current content of an introductory course on robotic systems are fully described. Various textbooks, laboratory teaching robots, digital vision systems, microcomputer systems, and computer languages are reviewed and compared relative to their merits in such an introductory course. Future directions in the robotics program at the Naval Academy are proposed.

WATTS, Jerry W., Associate Professor, co-author, "Steady State Computer Simulation of a 2.25 MW Regenerated Gas Turbine Generator Set Engine," David W. Taylor Naval Ship Research and Development Center Report PAS-86-41, October 1986.

The steady state and dynamic performance (and associated engine control system logic) of a gas turbine engine can be studied using an appropriate steady/state/dynamic engine performance computer simulation. A gas turbine engine computer simulation can be particularly instructive in studying the dynamic performance of prime mover configurations considered for possible shipboard generator set applications, since high quality, uninterrupted electrical power is essential. This report discusses using Dynote (an in-house gas turbine engine performance computer simulation) in simulating the following gas turbine engine configuration: regenerated, low pressure ratio compressor, single spool gas generator, variable geometry free power turbine. The steady state engine performance trends generated by using the simulation are compared to engine test data in the report. It is concluded that the performance trends are sufficiently representative of this configuration to warrant the continued effort required to incorporate control system logic and thereby give the simulation dynamic performance simulation capability. The dynamic performance simulation will be used in dynamic engine performance-control system studies.

The incorporation of control system logic and the control system/dynamic performance study of this configuration gas turbine engine will be covered in a separate forthcoming report.

Presentations

BECHERT, Thomas E., Associate Professor, **"Satellite Replenishment Simulation,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 24 April 1987.

BROCKUS, C. George, Associate Professor, **"Magnitude Scaling to Improve Conditioning,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

DWAN, Terrence E., Associate Professor, **"The Identification and Comparison of Two Energy Resource Models,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

KNOWLES, Kenneth A., Associate Professor, **"Computer Vision Enhancement Algorithms,"** American Society for Engineering Education, Mid-Atlantic Section Fall Meeting, University of Delaware, Newark, Delaware, 1 November 1986.

KNOWLES, Kenneth A., Associate Professor, **"What Isn't A Robot?"** United States Naval Academy

Sigma Xi, February Meeting, Annapolis, Maryland, 18 February 1987.

KNOWLES, Kenneth A., Associate Professor, **"Robot School House,"** 1987 Anne Arundel County Mathematics Conference, Anne Arundel Community College, Arnold, Maryland, 21 March 1987.

MITCHELL, E. Eugene, Professor, **"Modular Modeling for Digital Simulation,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 24-25 April 1987.

REED, Robert S., Visiting Professor, **"Model of a Magnetostrictive Actuator with Application to Simple Systems,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23 April 1987.

WATTS, Jerry W., Associate Professor, **"Blast Effect on Gas Turbine Engine Performance,"** Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 23-24 April 1987.

Division of English and History



THE OXFORD
COMPANION

ENGLISH LITERATURE

1

RABBLE



OXFORD

English

LIEUTENANT COLONEL LAURENCE W. MAZZENO, USA
CHAIRMAN

The range and diversity of research conducted by the English Department faculty during 1986-1987 bespeaks the strength of the program administered by this group of professional scholars.

Those projects sponsored by the Naval Academy Research Council included creative writing (a short story sequence), critical biographical studies, psychoanalytical theory, textual genesis, historical investigation of topical satire, and a study of the career and canon of a former Academy faculty member. Independent researchers covered a similarly broad spectrum of interests, and outnumbered the funded scholars by a margin of almost three to one. Some of those same people found time to supervise the research pursuits of midshipmen English majors whose work is also documented here.

The faculty record of publication and presentation is a clear manifestation of the pattern of ongoing scholarly activity. This year about twenty articles were printed in the company of an award-winning play, a published short story, an annual contribution to a prestigious bibliographic reference, and various news releases in military media. The many presentations, lectures, and addresses delivered by the faculty also attest to their collective commitment to their profession, their discipline, and most important, to the constant improvement of the educational program which engenders and is supported by the work herein summarized.



Sponsored Research

Cecilia's World

RESEARCHER: ASSISTANT PROFESSOR NANCY PROTHRO ARBUTHNOT
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This project-in-process involves a number of short stories linked by the major character, Cecilia. Each story covers a span of years from childhood to adulthood, moving occasionally into old age. Stylistically, the method is poetic-montage, or juxtaposition of isolated scenes or moments that, taken

together, compose a story of the coming-of-age of a woman in mid-century America. Several of the stories exist in rough draft form; they need further refinement. Five or six more remain to be written to complete a book – the goal of this project.

Loren Eiseley Bibliography

RESEARCHER: MAJOR CHARLES E. BECK, USAF
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This first part of a long-term project is developing a complete bibliography of the works of Loren C. Eiseley, anthropologist, essayist, and poet. The study began with bibliographic searches and travel to the archives at the University of Nebraska and

University of Pennsylvania. Furthermore, the project involves incorporating the information into a data-base format for ease of manipulation and update. Work is 75% complete at this time.

Edward Young: An Eighteenth-Century Literary Career

RESEARCHER: ASSISTANT PROFESSOR STEPHEN N. BROWN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The project is a book-length study of the career of Edward Young (1683-1765), eighteenth-century English poet. An Anglican clergyman for the last forty years of his life, Young was more widely known as a literary man, publishing vastly popular works in many genres from 1711 to 1762. Well-known, then, in his own time, and highly regarded for ninety years following his death during which his works were widely reprinted, he is a relatively neglected

figure today. Recent scholarship has offered some useful chapters and articles on Young, a reliable edition of his correspondence, and a descriptive introduction to his life and works, but we have yet to assess his whole achievement with sufficient penetration to recover him for our times. When published, this study will represent a significant step toward that recovery.

Paradox of Desire

RESEARCHER: ASSISTANT PROFESSOR LAURA CLARIDGE
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This project studies the ways in which unconscious desire motivates even the structure of British Romantic poetry. By using the revised Freud of Jacques Lacan, the researcher explores the intersection of language with sexuality and death. This is the investi-

gation seeks a better understanding of the poetics which underwrites what most scholars of the period regard as a particular homogeneity of Romantic desire.

The Genesis of *Moby-Dick*

RESEARCHER: ASSISTANT PROFESSOR ROBERT D. MADISON
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

Why did Herman Melville decide to write a whaling book at all? The present generation of Melville scholars have been "raised" to subscribe to the Hayford diagram that nearly shows that of all Melville's early travels, only the whaling voyage itself had not been incorporated into a book by 1850. The author's life, however, did not consist solely of his travels, and at any time he could, as he did later, write from other kinds of experience. The chronology of the composition of *Moby-Dick* is only beginning to be

understood. A closer look at the possible implications within Melville's journals and correspondence suggests some new possibilities, and scholars will have to study the *genetic* text of *Billy Budd* for demonstrable methods of composition, as well as examining *White Jacket* for other techniques already in place. Indeed, all of the "evidence" of composition during 1850 and 1851 will need to be scrutinized and perhaps re-evaluated. The researcher seeks more definitive answers through such scrutiny.

Scientific Satire in Chaucer's "The Summoner's Tale"

RESEARCHER: ASSISTANT PROFESSOR TIMOTHY D. O'BRIEN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The purpose of this project is to discover the extent to which Chaucer's satiric focus in "The Summoner's Tale" falls on medieval science. Most commentators have investigated the tale from the point of view of religious symbolism, when in fact much of the tale – and much of the framework surrounding it – seems to be dealing with the question of how valu-

able experience, a kind of scientific trusting of the senses, is in the process of recognizing and speaking the truth. The preliminary study of books and articles about the scientific issues of Chaucer's era has been completed, and the researcher is defining the ways in which the "Tale" appears to speak to these issues.

"U Here May Stand for Unfit"

RESEARCHER: ASSOCIATE PROFESSOR MICHAEL P. PARKER
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

Novelist, educator, painter, humorist, athlete, illustrator – thus William Oliver Stevens described himself in a 1931 capsule biography. Stevens pursued each of these avocations, and he excelled at them all. As professor of English at the Naval Academy from 1903 to 1924, Stevens revised the basic curriculum and wrote new textbooks while penning frequent articles for national publications like *The Yale Review* and *The Atlantic Monthly*; he twitted the staid citizens of Annapolis in a series of hilarious illustrated *Alphabets*; he published over twenty

works of fiction and non-fiction. In 1924 Stevens was dismissed by the Academy; surviving documents in Annapolis and at the National Archives outline Stevens's conflicts with Superintendent Admiral Henry B. Wilson and his later attempts to obtain a pension from the Navy Department. Stevens's career shed light on life in Annapolis and at the Academy during the golden years of the early twentieth century; it also crystallizes the problems faced by a civilian faculty member at a military institution during any period.

Independent Research

Graduate Student Attitudes Toward Research and Word Processing

RESEARCHER: MAJOR CHARLES E. BECK, USAF

Over the course of a graduate program, new users of word processors changed in their attitudes toward how word-processing affected the quality of their work. Results of the initial phase of this study were published in 1986. The follow-on portion of the

study is examining the relationship between change in attitudes toward writing quality and attitudes toward thesis research. The data is coded for processing on the SPSS system, waiting changes to upgrade the system in use at the Academy (SPSS-X).

Male Feminist Voices

RESEARCHER: ASSISTANT PROFESSOR LAURA CLARIDGE

This collection of essays opens with a theoretical introduction which the researcher has co-written with her colleague, Elizabeth Langland, from the University of Florida. The contributors, some of the most prominent scholars in the field (Wayne Booth, Frank

Lentricchia, Carolyn Heilbrun), all focus on a male author who tried (although eventually and inevitably it seems unsuccessfully) to escape the patriarchal bias of language.

Thomas Berger

RESEARCHER: PROFESSOR FRED M. FETROW

This project consists essentially of background study and research reading sufficient to complete a draft of a literary biography essay for inclusion in a standardized reference test. The article will include primary bibliography, an annotated secondary bib-

liography, and summarized accounts of the various influences upon Thomas Berger's life and work. The final draft has been completed and awaits publication.

The Revisionary Mode: Robert Hayden's Habits in Poetic Composition

RESEARCHER: PROFESSOR FRED M. FETROW

Work under this title purports to document, analyze, and apply toward critical interpretation the revisions and patterns of revision in the poetic canon of Robert Hayden (1913-1980). The various versions of some of Hayden's most revealing poems can reveal even more through a comparison of what he began with and what he changed enroute to a culminating version of particular poems. In a larger

perspective, the habits and patterns of this almost compulsive striving for perfection can illuminate the poet's values in artistic endeavor, as well as suggest possible insights into his moral vision. In sum, the changes made by the poet while his work was in progress may well tell us more about the finished product than that product reveals in and of itself.

The Poetry of Art; The Art of Poetry

RESEARCHER: PROFESSOR FRED M. FETROW

This project is an examination of Robert Hayden's poems in contemplation of, and commentary on other art forms, most notably paintings, sculpture, and design. Specifically, Hayden wrote at least half a dozen poems about art objects, and in these works he invariably linked the emotive and artistic impulses—both in the creation of art and in the response to it. A study of these poems could yield

an illustrated article with a sequence of reproduced art works (photos), faced by Hayden's poem, followed by a sustained interpretive commentary on the poems in question. Cumulatively, such a mini-collection of art and poetry should both visually and verbally extend our understanding of the relationships among art forms and the potential for explicating one form with another.

The Creative Writer's Handbook

RESEARCHERS: PROFESSORS PHILIP K. JASON
AND ALLAN B. LEFCOWITZ

The authors are providing a text for the high school and introductory college-level creative writing course. The book will isolate such special concerns as invention and research, working with language, point of view, keeping a journal, and the distinction between showing and telling. There will be major sections on the genres of poetry, fiction, and drama, plus advice on manuscript form, marketing,

using the word processor, and developing professional attitudes and habits. The authors take a problem-solving approach, providing a great many exercises and examples. The material is presented with the novice teacher in mind in order to be most helpful to both students and teachers. Glossary and anthology sections are planned to complete the format.

"Beautiful Things Made New": Transformations of Keats' *Hyperion* in Tennyson's "Morte D'Arthur" and "The Passing of Arthur"

RESEARCHER: ASSOCIATE PROFESSOR EILEEN TESS JOHNSTON

In their epic fragments, Keats and Tennyson both address the passing of old orders and break off on the verge of new ones. Tennyson's characters, especially Arthur, often speak and act like Keats's, and Tennyson's language and imagery echo and mirror Keats's hauntingly. Tennyson's consistencies with as well as his departures from Keats illuminate conti-

nuities and changes between Keats's Romantic and Tennyson's Victorian tempers. This eighteen-page article, based on research done on a Naval Academy Research Council grant in 1985, was submitted and revised at the behest of the editors of *Victorian Poetry*, who are currently reviewing the revised version of the article.

'A World of Trouble Within': Tennyson's *Maud*

RESEARCHER: ASSOCIATE PROFESSOR EILEEN TESS JOHNSTON

This forty-page article is a close reading of Tennyson's *Maud* in the light of several important critical issues: the problem of irony in the poem; the psychological theory underpinning the characterization of the poem's speaker; the relationship of *Maud* to

Romantic lyric and narrative poetry; and the significance of the poem's overall structure. The article has been submitted to a scholarly journal and is under consideration for publication.

Why I Read Detective Fiction

RESEARCHER: ASSOCIATE PROFESSOR EILEEN TESS JOHNSTON

This essay examines the author's personal reasons for reading detective fiction, and speculates on the nature of the appeal of this popular genre to many kinds of readers, especially academics. The essay is

intended for readers with a sophisticated literary background, but not necessarily for an academic audience. The manuscript is currently in circulation.

The Haircut

RESEARCHER: ASSOCIATE PROFESSOR EILEEN TESS JOHNSTON

This story dramatizes humorous and problematic aspects of contemporary love relationships between men and women. It focuses upon the trials of a

couple who are breaking up and selling their house. The story, designed for a popular reading audience, is currently in circulation.

Arnold, Bryce, and the Idea of American Democracy

RESEARCHERS: PROFESSOR ALLAN B. LEFCOWITZ
AND LIEUTENANT COLONEL LAURENCE W. MAZZENO, USA

This research will appear as a chapter in *Arnold in His Time and Ours*, a volume celebrating the centennial of Matthew Arnold's death. The article explores Arnold's attitudes toward American democracy through the lens of Bryce's *American Commonwealth*. The authors point out in their study that

Bryce appears to have in mind Arnold's articles on America, as they reach the conclusion that Arnold ultimately distrusted American democracy because he did not see how a mass culture could develop a high culture.

The Use and Transmission of the Dead Horse Chantey

RESEARCHER: ASSISTANT PROFESSOR ROBERT D. MADISON

Probably no one has seen the Dead Horse Ceremony as it was traditionally performed on British vessels of the nineteenth century. Only the records of nautical writers and folklorists have preserved the ceremony for modern readers. It would be helpful for those interested in the ceremony and chantey if all the descriptions could be assembled in one source. Readers then could compare for themselves the dif-

fering accounts to determine what most likely represents the known truth about the ceremony. This project is that attempt. Along with as complete a history as can reasonably be gathered, the researcher will include also many different versions of the song itself, with a description of the re-creation of the ceremony at the Mystic Seaport Museum.

Special Centenary Celebration Issue, *The Arnoldian: A Review of Mid-Victorian Culture*

RESEARCHERS: LIEUTENANT COLONEL LAURENCE W. MAZZENO, USA
AND PROFESSOR ALLAN B. LEFCOWITZ

1988 marks the one hundredth anniversary of the death of British poet and social critic Matthew Arnold. To celebrate that centennial a special issue of *The Arnoldian* will be issued, containing reflective essays by distinguished scholars on Arnold's life and work. The collection will include essays on Arnold's poetry, his drama, his religious writings,

his social criticism, and on his influence on future poets and critics. The volume will be sent to regular subscribers of the journal (which has been edited by members of the USNA English Department for twelve years), and will be available to individuals and institutions wishing to add it to their special collections.

A Concordance to Tennyson's Poetry

RESEARCHER: LIEUTENANT COLONEL LAURENCE W. MAZZENO, USA

The publication in 1969 of Christopher Ricks' new edition of Tennyson's poetry made the old Tennyson concordance, based on the Eversley edition of the poet's works, outdated. For several years, work has been progressing to bring out a new, computer-generated concordance. In 1983, members of the faculty at the University of Western Ontario offered the support of their institution, including graduate

research assistants, to help complete the project; through their help, a tentative agreement with Cornell University Press was reached to publish the completed volume. Though work was held in abeyance from 1984 until 1987, the issuance of the second edition of Ricks' work in February 1987 has made it possible to continue with a more authoritative and complete text.

One Teacher's Lessons

RESEARCHER: ASSOCIATE PROFESSOR CHARLES J. NOLAN, JR.

After twenty-three years of teaching, the author tried to draw some conclusions from his professional experience. Over the course of his career to date, the author has taught, either full- or part-time, at almost every level – from junior high to university – though most of his teaching has been in institutions committed to preparing future military officers, most of whom have chosen to major in technical

subjects. In exploring the lessons he has learned, he tried to go beyond the idiosyncratic to touch upon the common concerns of college English teachers. The method of investigation involved some research, but personal experience provided the major source for the conclusions drawn. The project is nearing completion; after it is finished, an article will be sent to a journal.

The 'Readerly' "Sir Launfal"

RESEARCHER: ASSISTANT PROFESSOR TIMOTHY D. O'BRIEN

This study examines a Middle English Breton lai as an example of tensions occurring in a narrative that is based on an oral model but which displays at the same time many of the self-conscious features of the kind of literary productions that Chaucer is remarkable for. The interpretation resulting from this study

is remarkably different from previous readings, which give the poet very little credit for what can be seen as a surprising self-consciousness about the status of his poem and his performance as teller. The project is complete, and the finished essay has been submitted for publication.

Thomas Carew and the Court of Charles I

RESEARCHER: ASSOCIATE PROFESSOR MICHAEL P. PARKER

This project will constitute a comprehensive study of the life and poems of Thomas Carew (1594/95-1640). The most accomplished poet working at the court of Charles I, Carew played a major role in shaping the public images that the Stuart monarchy attempted to project; his poetry enunciates the standards of cool elegance and restrained playfulness that the king demanded of his court. Carew, never-

theless, maintains a distance from the courtly culture he helped to create. His works dedicated to private patrons suggest values different from those he embraces in the poems on affairs of state, and the tension between these realms of experience provides the field for Carew's poetic contexts and, in so doing, illuminates the complex sensibility that underlies his best work.

Thomas Carew and the Saxham Masque

RESEARCHER: ASSOCIATE PROFESSOR MICHAEL P. PARKER

Thomas Carew wrote a dozen poems for the family of Sir John Crofts of Saxham Parva, but his relationship to the Crofts clan has never been the subject of sustained critical scrutiny. The researcher's discovery of a masque presented by the Crofts for King James I in 1620 or 1621 provides a focus for such a study. The masque is contained in Osborn MS. b 197, now in the Beineke Library at Yale University; the manuscript is a commonplace book compiled by Tobias Alston, a Suffolk neighbor of the Crofts. A preliminary examination of the texts

suggests that the masque was composed by Thomas Carew, perhaps in collaboration with members of the family. It is linked thematically with the poem Carew wrote welcoming James to Little Saxham; the verse form and details of diction and syntax all jibe with the poet's style during this period. This study will consist of an edition of the masque; a sustained account of the Crofts family at the Jacobean court; and a critical consideration of the ways in which poets and patrons worked together to attain precise political and social ends.

Suckling in Paris

RESEARCHER: ASSOCIATE PROFESSOR MICHAEL P. PARKER

The activities of Sir John Suckling after his precipitate flight from England in May 1641 have long been obscure. A hitherto unnoticed mention of Suckling in the Leicester correspondence describes his reception in Paris and provides some insight into his mental state during this period. The poet apparently

found exile uncongenial and fell prey to the prolonged depression that had afflicted him at other points in his career. This last-known reference to Suckling alive bolsters the tradition that he died a suicide sometime during 1641-1642.

A Complete Annapolis Bibliography

RESEARCHER: ASSOCIATE PROFESSOR MICHAEL P. PARKER

The literature concerned with the city of Annapolis is vast and scattered: it includes histories, guidebooks, periodical articles, directories, biographies, ephemera, etc. The goal of this project is to provide an annotated bibliography of all published items dealing with Annapolis; a general survey of avail-

able manuscript and newspaper materials; and a guide to locating and using Annapolis items at major area libraries. The completed bibliography will prove of value both to the serious student of local history and to the Annapolis resident.

Mark Twain at Home and Abroad

RESEARCHER: PROFESSOR DAVID O. TOMLINSON

Mark Twain liked to deal in the contrast of cultures. He was, of course, expert at observing the various cultures within the United States and characterizing the achievements and foibles of them in an entertaining fashion; but he used the same sense of humor in contrasting American with European or Mid-Eastern customs. The project has had two ends:

(1) allowed the collecting of materials for use in the classroom, and (2) presented materials for use in presentations and in publication. The researcher used some of the materials for a spring semester course, and other information was utilized in recent papers presented and published.



Research Course Projects

An Introductory Tutorial on Nota Bene

RESEARCHER: MIDSHIPMAN 1 C SAMUEL C. BAKER

ADVISER: INSTRUCTOR CAROL BURKE

The purpose of the project was to write a tutorial for the Nota Bene word processing program. Since Nota Bene is a complex and extremely powerful program, the researcher designed the tutorial as basic, initial assistance for the student just getting started on the program. In other words, the tutorial should

be used in conjunction with the Nota Bene user manual. The topics addressed in the tutorial are: the Nota Bene writing screen, file handling, document formatting, windows, footnotes, bibliography, defining, transposing, text-base, printing, and miscellaneous function keys.

The Night Journey

RESEARCHER: MIDSHIPMAN 1 C SEAN T. COUGHLIN

ADVISER: PROFESSOR PHILIP K. JASON

The project was essentially a two-phased process, a sequence of research and creative writing to culminate in drafts of short stories, one of which was to be refined into a finished product suitable for submission for publication. Initially, the researcher investigated materials on pirates and piracy in the seventeenth and eighteenth centuries, with an eye toward incorporating some of the contexts and culture into the planned fictional accounts. The

subsequent multiple drafts yielded a story about five captives trying to survive the night aboard a pirate ship upon which they are being held captive. The technique employed includes some experimentation with point-of-view as a means of conveying the horror of the victims' situation. Through the research and creative writing the researcher learned more about the craft of literary endeavor.

The Work "Ethic" of Gary Snyder

RESEARCHER: MIDSHIPMAN 1/C JOHN J. DENINE

ADVISER: ASSOCIATE PROFESSOR NEIL BERMAN

Although his writing spans four decades, throughout his career, Gary Snyder has shown remarkable clarity of vision. Labor forms one of the major unifying elements in his poetry, and his ideas on labor are indebted primarily to Zen Buddhist philosophy and the nineteenth-century American Transcendentalism of Thoreau. Both Thoreau and Buddhist discipline value hours of difficult, tedious manual labor as a means of clearing the mind of abstraction and reforming the relationship between man and nature that modern civilization has shattered. Snyder's ideas form a complex, carefully defined

work "ethic" that affirms hard manual labor more than the actual process. Since figurative language masks the value inherent in the process of work, Snyder rarely uses work as a metaphor in his poems. Instead, he follows Williams' invective, "No ideas but in things," and prefers simply to catalogue work and simple tools with reverence that reflects his Buddhist background and its emphasis on the importance of all objects, animate and inanimate. As a man rooted in both Eastern and Western cultures, Gary Snyder's work is valuable for comparison and growth towards mutual understanding.

Dissent in Utopian Thought and Fiction

RESEARCHER: MIDSHIPMAN 1 C MARY ELLEN GREEN
ADVISER: ASSOCIATE PROFESSOR STEPHEN M. ROSS

The writer of utopian fiction faces two difficult tasks: presenting a plausible alternative to the current situation, and persuading the reader to accept that society as both possible and desirable. In effect, the writer must anticipate and channel two forms of dissent: the reader's skepticism, and the restive citizens of his own invention. The proffered social systems differ widely across the range of utopian literature, but most works share dissent within

the systems themselves. Notably, writers will appeal to the reader's desire to agree with authority. To manage dissent within the systems themselves, the writers tend to establish authoritarian governments, or to provide ritual outlets for disagreement, to decrease the areas of the individuals' lives that are considered private rather than public, and to emphasize the collective over the individual good.

Writing Across the Curriculum: A Report

RESEARCHER: MIDSHIPMAN 1 C MARY ELLEN GREEN
ADVISER: INSTRUCTOR CAROL BURKE

The Writing Across the Curriculum (WAC) movement is essentially a recommitment by college faculties and administrations to ensuring their graduates' competence in written communication. The researcher investigated the movement in terms of its potential and problems, reading extensively in the literature, with special concentration on the writings of James Kinneavey, one of the chief proponents of WAC. According to Kinneavey, writing, like all learning, is not a product but a process; writing itself is a means not only of communication but of learning, and must be actively taught. Since writing within a given discipline helps define and display processes within that discipline, every scholar must take responsibility for writing within his own field.

Kinneavey outlines six goals for WAC programs: to use trained teachers of writing, to let students write for expert audiences in their chosen fields, to have students explain their disciplines to a general audience, to build a vertical sequence into the curriculum, to maintain standards throughout the program, and to make literacy the concern of the entire faculty. Specific programs choose different methods of pursuing these goals; however, the most common approaches split between whether all departments teach writing, or the English Department takes the primary responsibility. The several kinds of difficulties in fulfilling the goals can be surmounted through faculty cooperation and administrative support.

A Study of Boethius and Chaucer

RESEARCHER: MIDSHIPMAN 1 C ERIC N. LEONG
ADVISER: ASSISTANT PROFESSOR TIMOTHY D. O'BRIEN

For this project on the literature of Boethius and Chaucer, the researcher prepared three separate essays. The first explained the ways in which Boethius' *Consolation of Philosophy* served not only as a philosophical but also as a literary model for *Sir Orfeo*. In his second essay, the researcher

analyzed the complex religious parody taking place in the stories recited during "the third day" of *The Decameron*. The final essay was a lengthy comparison of "The Shipman's Tale" and an analogue in *The Decameron* in an effort to define those elements in "The Shipman's Tale" that are notably "Chaucerian."

The Role of the Writing Tutor

RESEARCHER: MIDSHIPMAN 1 C WALTER S. SECHRIEST, III

ADVISER: INSTRUCTOR CAROL BURKE

This research took the form of preparing for and fulfilling the role of a tutorial assistant in the Naval Academy's Writing Center, housed in and staffed by the English Department. After the researcher sat in on several tutorial sessions conducted by professional faculty members, and after reading the literature on tutorial techniques and styles, he was allowed to "take the helm" as a tutor for over a dozen one-on-one meetings with other students over the course of a semester.

Aside from the diverse experience of encountering fellow midshipmen with writing problems, the researcher also discovered that the role of the tutor

is itself an important aspect of the process. Virtually all writers, from the uncertain beginner to the polished professional, find occasion to need the intervention of reader response, to hear where they are and thus to gain direction in the composition process. Therefore, the tutor's strategies of motivation, instruction, and reinforcement must be well-planned, yet also in direct and immediate response to the situation as it develops. If a tutor can master the knack of learning what to respond to and how to respond to it, he becomes a real asset to the writer—a catalyst towards progress and effectiveness in written communication.

Research in Pedagogy

RESEARCHER: MIDSHIPMAN 1 C KEITH A. SPENCER

ADVISER: ASSOCIATE PROFESSOR MICHAEL P. PARKER

The project was conceived as an experimental alternative to HE470, Pedagogy in English. The researcher served as an assistant instructor for a section of HE111. The goal of the course was to expose the researcher to teaching in a classroom environment while enabling him to realize his potential as an instructor through working under the guidance of an experienced faculty member. Responsibilities

included attending each recitation session, either to observe or instruct; assisting in the preparation and grading of quizzes, daily assignments, and papers; keeping a daily journal of experiences and observations; and submitting a final paper based on the journal. The course enabled the student to experience at first hand all aspects of teaching, both within and without the classroom.

Methods of Prewriting

RESEARCHER: MIDSHIPMAN 1 C SCOTT E. URBACH

ADVISER: INSTRUCTOR CAROL BURKE

The project involved an investigation into the concept and practice of "prewriting," a term to designate the collective ideas, thinking, methods, and exercises a writer may use in beginning a rough draft of a writing task. The investigation resulted in a report, a guidebook intended for use by both student writer and tutor before, during, and after the prewriting stage of composition.

The initial portion of the guidebook format contains an explanation of the premises and rationale for prewriting as a process; thereafter, the author

provides definitions and various examples to assist the student writer in generating topic subjects, information, or focus. The guidebook concludes with suggested methods for organizing prewriting material into a essay form and includes the author's judgments on the value of the prewriting procedure. The completed handbook is expected to be of value to beginning writers who are having difficulty in the early stages of composition; it can be used on an individual basis or in conjunction with tutorial sessions.

Sword of Honor: The Vision of Evelyn Waugh and His Hope for a Fallen World

RESEARCHER: MIDSHIPMAN 1 C WILLIAM H. WEBER
ADVISER: ASSOCIATE PROFESSOR DAVID A. WHITE

The subject of this project is Evelyn Waugh's final work, the trilogy about the Second World War entitled *Sword of Honor*. This work was chosen because it represents the culmination of Waugh's vision and also his most highly developed protagonist, Guy Crouchback. The researcher's treatment of *Sword of Honor*, a work which chronicles the col-

lapse of values and traditions in western civilization, centers on the recognition that Waugh, while believing that mankind now exists in a world devoid of any distinctions between right and wrong, was still able to find hope for the world in the continuing tradition of the Catholic Church, a hope revealed through the content of this most challenging novel.

Literature of the American Outdoorsman

RESEARCHER: MIDSHIPMAN 1/C ELIZABETH WUESTENBERG
ADVISER: ASSISTANT PROFESSOR ROBERT D. MADISON

American Literature has in many ways shaped what modern readers see and feel with regard to their country. By studying works of authors such as James F. Cooper, Henry D. Thoreau, and Theodore Roosevelt, it is possible to show the developing and changing attitudes toward the American wilderness. This project seeks to demonstrate how those atti-

tudes have shaped an important segment of American literature. Within this framework of authors who explored the wilderness physically and psychologically, there exists a range of characters who are emphatically *not* in tune with nature. The final report of this research concentrates on the significance of these anomalies.



Publications

BECK, Charles E., Major, USAF, co-author, "The Effect of Word Processing on Writing Quality," *Technical Communication*, 33, 2 (1986), 84-87.

The perceived relationship between the use of word processors and quality of writing changed among students in a graduate program. At the beginning of their program, students at the Air Force Institute of Technology were asked how the use of a word processor affected the quality of their writing. Responses focused on time savings, attitude changes, and (to a lesser extent) on quality. Just before graduating, the students were asked the same question. This time, 85% of those answering saw improvement in quality due to their use of word processors. The study has implications for overall academic curricula, construction of writing courses, and for future student occupations.

BECK, Charles E., Major, USAF, co-author, "Therapy Implications of Shame in Divorce Counseling," *Journal of Pastoral Counseling*, 21, 2 (Fall-Winter 1986), 93-104.

Divorced persons may experience a distinct feeling of shame that has not previously been identified by counselors. If divorced persons have internalized an ideal concept of marriage based on religious values, their subsequent divorce intensifies a shame reaction. They may also experience hostile community reactions for their inability to achieve the ideal. Although counselors routinely treat the issue of guilt, the distinct characteristics of shame require separate therapy techniques. By treating both the nature of the religious ideal and the presence of shame, counselors can help divorced persons overcome the negative effects of the intense shame often associated with a divorce.

BECK, Charles E., Major, USAF, co-author, "Communication Workshop for Teaching Public Administration," *Proceedings of the Tenth Annual International Conference on Teaching Public Administration - Looking Ahead: Strategies for the Next Decade*, Washington, DC, 30 April 1987, pp. 9-17.

A communication workshop can show administrators how a speaker's patterns set up either defensive or supportive climates for the listener. Increasing involvement in managerial responsibilities unintentionally reinforces defensive patterns in the communication. Understanding Jack Gibbs' principles of defensive communication, administrators can improve their effectiveness in dealing with clients and co-workers.

CLARIDGE, Laura, Assistant Professor, "Tess: A Less Than Pure Woman Ambivalently Presented," *Texas Studies in Literature and Language* 23 (1986), 324-338.

Though Thomas Hardy's *Tess of the d'Urbervilles* is often discussed in terms of some one significant flaw, critics have missed the larger problem: Hardy's too close identification with his hero creates a formal incoherence that absorbs all other minor inconsistencies.

FETROW, Fred M., Professor, "Portraits and Personae: Characterization in the Poetry of Robert Hayden," *Black American Poets Between Worlds*, ed. R. Baxter Miller, Knoxville: University of Tennessee Press, 1986, pp. 43-76.

An examination of Robert Hayden's pantheon of racial heroes, personal ancestry, historical figures, "real" characters, and of several multi-voiced personae in autobiographical revelation, the analysis focuses on the techniques and results of Hayden's work in character portrayal. Through a psychological density of both poem and personage, often accomplished with dramatic monologue and its attendant irony, the poet brings to life "real" people from out of the past, as well as imagined characters, composite in source, but individualized in poetic presence. By extension the study reveals much about the poet's primary topics, themes, and values, and when considered collectively, Hayden's portraits demonstrate this artist's contemporary relevance and timeless value as a chronicler of, and commentator on American society and the human condition.

FETROW, Fred M., Professor, "Robert Hayden," *Contemporary Authors Bibliographic Series*, Vol. 2, *American Poets*, ed. Ronald Baughman, Detroit: Gale Research Company, 1980, pp. 107-128.

An introductory summary of Hayden's life, career, and works, this study includes a primary bibliography, an annotated secondary bibliography, and a substantial essay in description of the scope and nature of the scholarly work done on Hayden and his canon. As the essay covers those critical assessments of Robert Hayden's poetry, it directs the reader toward the elements of that poetry most in need of attention and scrutiny.

FETROW, Fred M., Professor, "Robert Hayden," *Concise Dictionary of American Literary Biography*, Vol. 5, *The New Consciousness, 1941-1968*, Detroit: Gale Research Company, 1987, pp. 259-269.

This reference article is a summary of the work by and about the contemporary Black poet, Robert Hayden (1913-1980). While the content is styled as a summary, it consists of: (1) a listing of Hayden's primary works such as poetry, prose essays, and interviews; (2) an annotated secondary bibliography of books and articles written about Hayden and his canon; and (3) a sustained descriptive essay in evaluation and explanation of the major books and articles about Robert Hayden. The materials of the entry include also a graphic "contextual diagram" of the historical, cultural, and sociological influences upon the author.

JASON, Philip K., Professor, "The Afterpiece: Origins and Early Development," *Restoration and 18th Century Theatre Research*, 1 Second Series (July 1980), 53-63.

The development of the double bill on the London stage during the late 17th and early 18th century was caused by growing competition between the two licensed theatres. A review of the performance calendars indicates that during periods of single theatre monopoly few double bills were put on, while the number increased markedly during periods of competition. The afterpiece, usually a short farce, came into being as the second play on the day's bill. It has been determined that multiple entertain-

ments could swell theatre audiences. Once established, the afterpiece became a new opportunity for aspiring playwrights to reach the stage. Moreover, charging aftermoney for late admission became standard practice as many theatre-goers decided to attend only the second play on the bill.

JASON, Philip K., Professor, "The Princess and the Frog: Anais Nin and Otto Rank," *Anais, Art and Artists*, ed. Sharon Spencer, Greenwood, Florida: The Penkevill Publishing Company, 1986, pp. 13-22.

A careful comparison of Nin's diary volumes for the early and mid 1930s and her short story "The Voice" (1939) reveals the abstracted title character of the story to be based on Otto Rank, the trailblazing psychotherapist who was Nin's analyst and, briefly, her employer. Ironically, under the cloak of fiction, Nin reveals more about her relationship with Rank than she does in the heavily edited diary selections. The story's portrait of Rank as Nin's awkward, noble, yet finally unattractive suitor extends our understanding of how each influenced the other, and reading the works against one another brings us close to Nin's complex practices as diarist and fiction writer.

JASON, Philip K., Professor, "Percy MacKaye," *The Dictionary of Literary Biography*, Vol. 54, *American Poets, 1880-1945*, Detroit: Gale Research Company, 1987, pp. 274-283.

Percy MacKaye (1875-1956) was one of the most popular and successful American playwrights and poets of the first three decades of this century. The great majority of his poems, plays, and other entertainments are part of his optimistic quest for an American identity, a thriving American culture distinct from European models and satisfying to all citizens. MacKaye based many of his works on American folklore and the deeds of American heroes. His most original creation was the civic masque, a dramatic entertainment in which all of a community's citizens took part. The public manner and unfashionable buoyancy of his work caused it to drop from sight when the literature of private, despairing vision gained ascendancy between the world wars.

JOHNSTON, Eileen Tess, Associate Professor, *The Arnoldian: A Review of Mid-Victorian Culture*, Vol. 13, Numbers 1, 2; Vol. 14, Number 1 (Winter 1985-86, Summer 1986, and Winter 1986-87).

The editor listed above wrote the Editor's Page and edited and arranged the articles, notes, and reviews on mid-Victorian subjects, especially on Matthew Arnold and his circle and on mid-Victorian non-fictional prose.

LEFCOWITZ, Allan B., Professor, "The Gates of Paradise," *Plays in Progress*, The Writer's Center (19-20 June 1986).

This play, which won the Maryland State Fellowship for 1986-1987, concerns a married couple who, on their return from a second honeymoon to Italy, are asked to participate in a study of marriage. Their friends call the Wedlers a perfect couple, but we see that in fact their marriage is on the rocks. Dr. Hartz, the investigator, actually has heard this, and while apparently testing the Wedlers as a perfect couple, is actually evaluating the tentative nature of the marriage. As a complication, Mrs. Wedler fancies that Dr. Hartz is the adult version of a young man she and her husband had met years ago on the honeymoon to Italy. In the climax of the play, Dr. Hartz is revealed as a trickster, the Wedlers reject his view that a marriage can be seen as a sum of statistical variables, and they throw Hartz out of their apartment. In the end we see that the Wedlers' marriage will survive for a while longer.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "Morris West," *Beacham's Popular Fiction in America*, Vol. 4. Washington, DC: Beacham Publishing, 1986, pp. 1461-1466.

Australian-born Morris West has become a best-selling author world-wide during the past thirty years. His novels usually focus on contemporary social issues. This reference article examines his growing popularity and provides a detailed analysis of three novels, *The Navigator*, *The Shoes of the Fisherman*, and *Proteus*.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "Herman Wouk," *Beacham's Popular Fiction in America*, Vol. 4. Washington, DC: Beacham Publishing, 1986, pp. 1483-1489.

Since the publication of *The Caine Mutiny* in 1951, Herman Wouk has been a major voice in American popular fiction. Known primarily for his novels of the Navy in World War II, he has also written numerous accounts centered on his own experiences of the Jewish community in America, and on other subjects. This reference article explores the reasons for his popularity, and contains an extensive analysis of *The Caine Mutiny*, *War and Remembrance*, and *Inside, Outside*.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "John J. Pershing," *Great Lives from History, American Series*. Englewood Cliffs: Salem Press, 1986, pp. 1785-1789.

As its commanding general, American military leader John J. Pershing played the key role in the success of the American Expeditionary Force in World War I. This brief "life" reviews the career of one of America's military heroes, tracing his military assignments after graduation from the U.S. Military Academy in 1886 through tours on the Western Plains, in the Philippine jungles, and on the staff of Army Headquarters in Washington, D.C., to his promotion to brigadier general (from the rank of captain) by President Theodore Roosevelt, to his eventual command of American Forces in World War I.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "William Frederick (Buffalo Bill) Cody," *Great Lives from History: American Series*. Englewood Cliffs: Salem Press, 1986, pp. 502-506.

The life of "America's greatest showman," Buffalo Bill Cody, is replete with examples of daring, courage, high living, and adventure. This brief biography examines the events that led Cody from his career as a plainsman to the cities of America and Europe, where his Wild West Show was for two decades the premier attraction for city dwellers who wanted a taste of life on the untamed American plains.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "The Adventure of the Speckled Band" [by A. C. Doyle], *Masterplots II: Short Story Series*, Englewood Cliffs: Salem Press, 1986, pp. 31-33.

This entry provides a reference guide for one of Arthur Conan Doyle's most famous Sherlock Holmes stories, explaining the methodology by which the author is able to achieve suspense and preserve the literary qualities of the best mystery stories.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "Hunting Season" [by Joanne Greenberg], *Masterplots II: Short Story Series*, Englewood Cliffs: Salem Press, 1986, pp. 1085-1087.

This essay provides an explication of Joanne Greenberg's story of a young mother who must let her epileptic son grow up and achieve independence. The techniques of characterization and point of view are examined in some detail to show how Greenberg uses them to best advantage.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "The Lottery" [by Shirley Jackson], *Masterplots II: Short Story Series*, Englewood Cliffs: Salem Press, 1986, pp. 1406-1408.

In this brief essay, the techniques of characterization and point of view, as well as Jackson's use of understatement, are highlighted as the key to understanding her success in this, one of the most famous and oft-anthologized stories in contemporary America.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "The Supremacy of the Junza" [by Joanne Greenberg], *Masterplots II: Short Stories Series*, Englewood Cliffs: Salem Press, 1986, pp. 2285-2287.

This reference article offers an extended analysis of Greenberg's short story about a man who is forced to confront his own lack of commitment to ideals when he must deal with a neighbor who is truly committed to the cause of conservation. The essay highlights Greenberg's masterful use of point of view and careful plotting which emphasize the juxtaposition of dramatic scenes for effect.

MAZZENO, Laurence W., Lieutenant Colonel, USA, "Two Little Soldiers," [by Guy deMaupassant], *Masterplots II: Short Story Series*, Englewood Cliffs: Salem Press, 1986, pp. 2442-2444.

In this short essay, deMaupassant's special skill at narration and his careful use of point of view are discussed in detail. The review provides a rationale for the story's enduring greatness, despite its lack of surface sophistication.

NOLAN, Charles J., Jr., Associate Professor, Contributions to the *Annual Bibliography of English Language and Literature*, Volume 58, eds. Michael Smith and Mary Jean DeMarr, Leeds, Great Britain: Modern Humanities Research Association, 1986.

Contributions to the *Annual Bibliography* come from a careful review of the many issues of fourteen journals ranging from *Anthropological Linguistics* to the *International Philosophical Quarterly*. The contributor examines and notes any article, edition, book, or thesis, published in any language, that has an important link to English or American language or literature and any ancillary work that bears significantly on those fields. Using a specialized format, he then prepares bibliography cards for such items and forwards them to the American editor, who, in turn, sends the American contribution to Leeds, Great Britain, where the *Annual Bibliography* is published. The result each year is one of the two major bibliographies in English studies.

O'BRIEN, Timothy D., Assistant Professor, "Archetypal Encounter in 'Mending Wall,'" *American Notes & Queries*, 24, 9&10 (May-June, 1986), 147-151.

We cannot fully appreciate the complexity of Frost's "Mending Wall" without recognizing the ambivalent status of its speaker. Prior to this recognition, all readings of the poem must accept the seemingly self-controlled and witty speaker as the authoritative point of view in the poem. One way of appreciating the ambivalence of the speaker's attitude toward the wall and his neighbor is to examine it in terms of Jung's notion of the archetypal encounter each personality must have with its shadow. In Frost's poem the speaker's ridicule of his neighbor is actually a projection of his own unrecognized, distasteful energies onto the neighbor, who is never allowed an autonomous existence in the poem.

OLIVER, Keith, Captain, USMC, "Sometimes, It Helps To Be A Little Crazy," *Proceedings of the Naval Institute*, 112, 11 (November, 1986), 78-79.

This essay won Honorable Mention in the Vincent Astor Leadership Essay Contest. It is a look at using the unlikely as a positive force in military leadership. Historical analysis, personal experience, and classroom discussion brought out the necessity for a finely-tuned sense of the absurd to succeed in the rigors of combat and in certain high-stress peacetime settings.

OLIVER, Keith, Captain, USMC, "Gunny wears the stripes . . .," *The Boot* (24 April 1987), p. 3 [Parris Island, South Carolina].

This is a published news release explaining the role of the marine senior enlisted man at the U.S. Naval Academy. The article provides biographical information on Gunnery Sergeant Mac Elvington and features interviews with other staff members and midshipmen.

OLIVER, Keith, Captain, USMC, "Naval Academy offers career opportunities," *Hawaii Marine* (30 April 1987), p. A-4 [Kaneohe Bay, Hawaii].

This news release discusses the historically-strong ties between the Naval Academy and the Marine Corps. Famous Academy graduates (such as Lejeune and Webb) are featured, as well as information on how enlisted Marines may apply for admission to the Academy.

PARKER, Michael P., Associate Professor, "Diamond's Dust: Carew, King, and the Legacy of Donne," *The Eagle and the Dove: Essays Reassessing John Donne*, ed. Claude J. Summers and Ted-Larry Pebworth. Columbia: University of Missouri Press, 1986, pp. 191-200.

The two best-known elegies on John Donne, those by Henry King and Thomas Carew, are related in a way that has remained unnoticed heretofore. In

brief, King's poem responds to Carew's and attempts to refute it. Carew's fascination with Donne's achievement leads him to explore the ways in which his poetry, both sacred and profane, has transformed English verse. King, Donne's literary and spiritual executor, attempted to suppress the master's early amatory poems lest their publication undermine the edifying legend of the saintly Donne that he and Izaak Walton had disseminated. Thus, King lashes out at Carew's "unauthorized" elegy in his own piece, insisting that Donne is inimitable to prevent the indiscriminate exploration of his poetic legacy. Happily, Donne's poems were published despite King's efforts; Carew's elegy, moreover, remains as the most incisive and suggestive critical comment on Donne by a contemporary.

TINSLEY, Molly B., Associate Professor, "Outbound," *New England Review/Bread Loaf Quarterly*, 9, 3 (Spring 1987), 300-310.

This story of a Navy family stationed in Stockholm, Sweden (embassy attaché), is told from the point of view of the oldest, pre-adolescent child, a girl. She recounts her own difficulties adjusting to a French school as well as her mother's difficulties with the new culture and climate. The central action in the story is a lesson in independence for the daughter.

WHITE, David A., Associate Professor, "Miguel DeCervantes," *Critical Survey of Drama: Foreign Language Series*. Englewood Cliffs: Salem Press, 1986, pp. 361-368.

The essay describes Cervantes' place in the Spanish theatre and his two major contributions—his stirring of critical debate about the nature and role of drama and his one long play of note and numerous interludes. An analysis of his dramatic epic, *The Siege of Numantia*, examines its unique status in Spanish drama, and a discussion of the interludes of Cervantes shows him developing some major themes that would also appear in his masterpiece, *Don Quixote*.

Presentations

ARBUTHNOT, Nancy Prothro, Assistant Professor, "The Image of the Indian in Richard Hugo's Poetry," Western Literature Association Conference, Durango, Colorado, 10 October 1986.

BECK, Charles E., Major, USAF, "Writing for Impact," Navy Medical Senior Officer Leadership and Management Education and Training Course, Naval School of Health Sciences, Bethesda, Maryland, 15 January 1987.

BECK, Charles E., Major, USAF, "Workshop in Executive Writing," Academic Chairpersons: Organizational Structure, Change, and Development, Fourth Annual Conference, Orlando, Florida, 19 February 1987.

BECK, Charles E., Major, USAF, "Using Word Processing Research: Options for Outlining, Writing, and Rewriting," College English Association, Middle Atlantic Group, Catholic University of America, Washington, DC, 7 March 1987.

BECK, Charles E., Major, USAF, co-author, "Communication Workshop for Teaching Public Administration," Tenth Annual International Conference on Teaching Public Administration—Looking Ahead: Strategies for the Next Decade, Washington, DC, 30 April 1987.

BECK, Charles E., Major, USAF, "Graduate Student Attitudes toward Word Processing and Thesis Research," Thirty-fourth International Technical Communication Conference, Denver, Colorado, 13 May 1987.

BECK, Charles E., Major, USAF, "Conducting Workshops in Editing," Thirty-fourth International Technical Communication Conference, Denver, Colorado, 12 May 1987.

BURKE, Carol, Instructor, "The Folklore of Women in Prison," American Folklore Society's Annual Conference, Baltimore, Maryland, 24 October 1986.

BURKE, Carol, Instructor, "Whom Do We Serve?," Southeastern Writing Center Association Annual Conference, Panama City, Florida, 10 April 1987.

CLARIDGE, Laura, Assistant Professor, "Pope's Rape of Excess," Gender Distinctions in Eighteenth Century Literature, South Central Modern Language Association Meeting, New Orleans, Louisiana, 30 October 1986.

CLARIDGE, Laura, Assistant Professor, "The Real Unorthodoxy of Cain," Romantic-Victorian Division, South Atlantic Modern Language Association Meeting, Atlanta, Georgia, 14 November 1986.

CLARIDGE, Laura, Assistant Professor, "Shelley's Truth: The Female Other as Silence," Modern Language Association Convention, Special Session, New York, New York, 28 December 1986.

CLARIDGE, Laura, Assistant Professor, Commentator, "The Philosophy of William Godwin," Colloquium: British Responses to the French Revolution, The Folger Institute, Washington, DC, 20 March 1987.

CLARIDGE, Laura, Assistant Professor, Commentator, "Canon Revision: The Difference It Has Made," Association of Departments of English, Regional Conference, Annapolis, Maryland, 5 June 1987.

FETROW, Fred M., Professor, "Pilate's Belly and the Narrative Texture of Morrison's *Song of Solomon*," Modern Language Association Convention, Special Session, New York, New York, 29 December 1986.

FETROW, Fred M., Professor, "Black Heroism in Robert Hayden's Poetry," Black History Month Lecture delivered to Construction Battalion Unit #403, U.S. Naval Station, Annapolis, Maryland, 20 February 1987.

GILLILAND, C. Herbert, Assistant Professor, "The Midwatch Muse: U.S. Navy New Year Logs," Popular Culture Association Meeting, Montreal, Canada, 29 March 1987.

JASON, Philip K., Professor, Poetry Reading, Montpelier Cultural Arts Center, Laurel, Maryland, 17 October 1986.

JASON, Philip K., Professor, "**The Familiar and the Fresh in Falconer's *Shipwreck***," East-Central American Society for Eighteenth-Century Studies Annual Meeting, Fredericksburg, Virginia, 1 November 1986.

JASON, Philip K., Professor, "**Vietnam in Verse: The Poetry and the Packaging**," Popular Culture Association Annual Meeting, Montreal, Canada, 26 March 1987.

JASON, Philip K., Professor, Poetry Reading, Howard County Community College, Columbia, Maryland, 26 April 1987.

MADISON, Robert D., Assistant Professor, "**Literature of the Sea: North of Bermuda**," Sea Experience: A Conference on the Educational Use of Sailing School Vessels, Portsmouth, New Hampshire, 3 October 1986.

MADISON, Robert D., Assistant Professor, "**Melville's Natatorium: The Genesis of *Moby-Dick***," Department of English Athenaeum, U.S. Naval Academy, Annapolis, Maryland, 18 November 1986.

MADISON, Robert D., Assistant Professor, "**Sea Biscuits: Trailing the Dead Horse Chantey**," Mystic Seaport Museum Sea Music Symposium, Mystic, Connecticut, 13 June 1987.

NOLAN, Charles J., Jr., Associate Professor, "**One Teacher's Lessons**," College English Association Annual Convention, Charleston, South Carolina, 4 April 1987.

OLIVER, Keith, Captain, USMC, "**Photojournalism and the Big Picture**," United States Marine Corps Combat Correspondents Association Meeting, Dallas, Texas, 26 September 1986.

PARKER, Michael P., Associate Professor, "**Daveant, the Dwarf, and the Politics of 'Jeffereidos'**," Seventh Biennial Renaissance Conference, Univer-

sity of Michigan-Dearborn, Detroit, Michigan, 18 October 1986.

PARKER, Michael P., Associate Professor, "**Carew and the Crofts: Saxham Revisited**," South Atlantic Modern Language Association Meeting, Atlanta, Georgia, 14 November 1986.

ROSS, Stephen M., Associate Professor, "**Amputated Speech: Language and Dissent in Margaret Atwood's *The Handmaid's Tale***," Society for Utopian Studies Meeting, Asilomar, California, 2 October 1986.

TOMLINSON, David O., Professor, "**Mark Twain and the Power of Invention**," Friends of the Library, University of Pennsylvania, Philadelphia, Pennsylvania, 29 September 1986.

TOMLINSON, David O., Professor, "**What is Rare? What is Valuable?**" Friends of the Library, Georgetown University, Washington, DC, 23 November 1986.

TOMLINSON, David O., Professor, "**Realism and Romanticism: John Pendleton Kennedy and Mark Twain in Europe**," Mid-Hudson Modern Language Association Meeting, Poughkeepsie, New York, 1 December 1986.

TOMLINSON, David O., Professor, "**Research and Teaching: Walking and Chewing Gum at the Same Time**," Mid-Atlantic College English Association Meeting, Catholic University, Washington, DC, 7 March 1987.

TOMLINSON, David O., Professor, "**Mark Twain's American Dream; Mark Twain's Universal Nightmare**," Colloquium on Literature of the Nineteenth Century, U.S. Naval Academy, Annapolis, Maryland, 23 April 1987.

WOOTEN, John, Associate Professor, "**Academic Agonistes**," Seventy-third Annual Meeting of the Association of American Colleges, Washington, DC, 16 January 1987.

History

PROFESSOR FREDERICK S. HARROD
CHAIRMAN

During the past year, the History Department faculty undertook extensive research and was active in presenting the results of this research in a variety of forums. The discipline of history encourages diversity, and the work of the faculty encompasses a range of subjects and methodologies. Projects and presentations range from the study of religious cults in ancient Athens to riverine warfare in Vietnam. A statistical summary provides a quick view of the Department's endeavors; in the past year, members of the department published one book, edited another, served as series editor for four books, published eight articles and reviews, and presented 35 papers.

Numbers alone, of course, say nothing about the quality of work. In this regard, the Department is pleased at the high standards of research and writing reflected in these activities. Among the publications, for example, are the article, "A Tyranny of Words: Language, Poetry and Antimodernism in England in the First World War," by Associate Professor Theodore Bogacz, in the *Journal of Modern History*, the premier journal in its field, and the book, *Hope Among Us Yet: Social Criticism and Social Solace in Depression America*, by Assistant Professor David Peeler, published by the highly-regarded University of Georgia Press.

This year's publications also reveal the Department's participation in the encouragement of scholarship in naval history. In the Spring, *Naval History: the Proceedings of the Sixth Naval History Symposium*, edited by Associate Professor Daniel Master-son, was published. This symposium has become the major forum for scholarship dealing with naval history, and the publication of selected papers has ensured high quality in the submissions seeking inclusion on the program.

Faculty members have also supervised 15 midshipmen research projects. These projects have sup-



plied an important opportunity for midshipmen to pursue rigorous, scholarly research on topics not possible in regular classes.

Scholarly activity has contributed to the life of the Department in ways which cannot appear in the following listings. Faculty members have participated in an extended series of Works-in-Progress seminars in which individuals submit drafts of papers, articles, and chapters to the review and comment of colleagues. They have also been particularly successful in conveying their own excitement about learning while in the classroom, which has enhanced the learning environment for the midshipmen.

Sponsored Research

The Hauberk and the Cross: Warrior Clerics in Early England

RESEARCHER: ASSOCIATE PROFESSOR RICHARD P. ABELS
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The attitude of the English clergy toward warfare changed dramatically in the course of the ninth and tenth centuries. In the Conversion Period (seventh century), the disjunction between the *miles Christi* and the *miles regis* (the soldier of God and the earthly warrior) was absolute. Clerics performed no military service but instead were expected to support the martial aspirations of their royal lords through their prayers. In the ninth century, due to the Viking invasions, military service was imposed upon all hereditary properties, whether lay or ecclesiastical, with the expectation that the lord of the estate would lead his contingent of warriors. In practice, therefore, abbots and bishops often led troops to battle, and it was not uncommon for such men to be entrusted with the command of entire military expeditions. Alfredian propaganda painted English resistance to the pagan Vikings as a holy war, and this also contributed to making warfare an accept-

able activity for clerics. Thus, despite the fact that cannon law prohibited a priest from shedding blood, English clerics of the ninth and tenth centuries often led troops and fought in battle.

The Benedictine monastic revival of the late tenth century challenged this. Aelric of Eynsham and Archbishop Wulfstan of York both condemned priests who engaged in combat, and both used the idea of the Three Orders to reinforce canonical prohibitions against such behavior. But despite such condemnations, ecclesiastics continued to lead armies. Thus clerical practice and ecclesiastical ideology were in conflict from the beginning of the eleventh century until the battle of Hastings brought the English Church into line with continental practices.

The research on ecclesiastical attitudes toward and participation in war is now completed.

Dual Object Theories of Identity, Existence, and Modality

RESEARCHER: LIEUTENANT JAN C. DEJNOZKA, USNR
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The researcher is working on a 120-page monograph presenting a new theory, qualified object theory, to account for various problems involving informative identity judgments, informative existence judgments, and *de re* and *dicto* modal judgments. Besides a review of contemporary theories, a brief

review of historical positions will be included. Current progress includes 150 pages of draft of previously published material, and plans to expand the monograph into a book. The subject matter is ontological. The method of investigation is principally analytic and dialectical.

Computer-Aided Instruction in Logic

RESEARCHER: PROFESSOR DAVID E. JOHNSON

SPONSOR: INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE (OMN)

The project addresses the inclusion of logic software in HP230, Introduction to Philosophy and Logic. Because of time constraints, logic has been slighted in this course. This project will identify and evaluate software that is appropriate to the level of students in the course, and that will tutor them in logic on their own PCs. The end product will be developed or modified courseware material that will have a flexible application to this course and to other courses as a component in logic and/or critical thinking. The research will: examine already avail-

able software; explore developing software unique to the Naval Academy; and search for texts in the Introduction to Philosophy that may be specifically designed for students who have had instruction in logic. The main value of this project will be to enhance the ability of the students in HP230 to use logic in the analysis of philosophical texts and issues. The project is presently in its first phase; i.e., examining already available software. This project has the potential for widespread application to much of the Naval Academy curriculum.

Century's End: America Between a Past and Future

RESEARCHER: LIEUTENANT COMMANDER ANDREW KOCZON, USNR

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This is an investigation of how Americans perceived, thought, and talked about the meaning of the nineteenth century and the possibilities of the twentieth

century. It is an attempt to establish a consciousness and a cultural identity for America in 1900 at the turn of the century.

The Mind's Eye: Photography in Twentieth-Century America

RESEARCHER: ASSISTANT PROFESSOR DAVID P. PEELER

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This project is an examination of the growth of American photography in the twentieth century. It examines the ideas and values of leading American photographers, and the ways in which they brought those beliefs and values to fruition in their work. The project fills a gap in the existing scholarship, for while there is a substantial body of art criticism on the medium, there is no substantial scholarly

treatment of the ideas associated with creative photography. The principle question is: In what ways did these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their own work that even the simplest fact cannot be presented without altering its "pure" objectivity in some way?

Samuel Baldwin Marks Young: The First Army Chief of Staff

RESEARCHER: ASSISTANT PROFESSOR WILLIAM R. ROBERTS
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This research project is a biographical study of Samuel Baldwin Marks Young (1840-1924), the first chief of staff in the United States Army. An examination of Young's career and contributions to the creation of the General Staff will help to illuminate the nature of military professionalism and civil-military relations to the late nineteenth and early twentieth-century Army.

Research for this project has centered on archival sources in the Military History Institute at Carlisle Barracks, Pennsylvania; the Manuscripts Division of

the Library of Congress; and the National Archives. The collections at each of these institutions have been inventoried and a substantial number of records in these collections have been examined. In addition to looking at other records in these institutions, contemporary newspapers and genealogical records still need to be examined. The goal of this research is to produce a biography of Young, as well as one or two journal articles on his significance as an Army officer whose career and accomplishments have been overlooked by historians until now.

From Knowledge, Sea Power: A History of Research at the U.S. Naval Academy

RESEARCHER: ASSOCIATE PROFESSOR JACK SWEETMAN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The U.S. Naval Academy was founded in October 1845. Its mission has always been to prepare midshipmen to become professional officers of the naval service. It has therefore and rightly remained essentially an undergraduate, teaching institution. As a natural result of the relationship between classroom teaching and intellectual creativity, however, the Academy has also been the scene of wide-ranging research activities by both its faculty and, in recent years, midshipmen. It was, for example, as a lecture demonstration that in 1877 Ensign Albert A. Michelson began conducting the experiments to measure the speed of light that led him to become the first American to receive the Nobel Prize for physics. Similarly, it was research done in support of the Academy's naval history course that, early

in this century, brought the History Department the reputation it still enjoys as a center for the study of naval history. Since the 1960s, the development of a sponsored research program administered by the Naval Academy Research Council (NARC), the creation of research professorships, and the initiation of the Trident Scholars Program have greatly enhanced the research opportunities of faculty and midshipmen alike. No general history of research, broadly defined, at the Naval Academy now exists. The aim of this project is to produce such a history, approximately 10,000 words in length, describing significant research conducted by the faculty (officer and civilian) at the Naval Academy from its foundation to the present and tracing the growth of the sponsored research program.

Independent Research

Introduction to the Hertfordshire Domesday Book

RESEARCHER: ASSOCIATE PROFESSOR RICHARD P. ABELS

During the summer of 1986, research and writing was done on an introduction to the Hertfordshire volume of the facsimile edition of the Domesday Book produced by Alec Historical Editions in celebration of the 900th anniversary of William the Conqueror's great land register. The introduction included an historical survey of Hertfordshire from

the Roman period to 1086; a review of recent scholarship relating to the early history of this county; an examination of the geography, economic resources, and tenurial structure of Hertfordshire in 1066 and 1086; and an analysis of the social structure of the county before and after the Conquest.

The Transformation of English Culture, 1910-1922; Tradition, Modernity and the Great War

RESEARCHER: ASSOCIATE PROFESSOR THEODORE W. BOGACZ

As the title implies, this book will be a synthetic study with broad implications for the cultural and social history of modern England. Examination will be conducted of important aspects of English culture as they underwent radical change under the impact of total war. Among other areas to be studied are: the transformation of language during World War I; the reception of new views of psychology and mental illness under the impact of the shell-shock crisis; the triumph of the modernist vision in the

fine arts as other styles failed to capture the nature of modern war; and ultimately the growing acceptance of the conditions of "modernity" in English culture as a whole. The years 1910-1922 in England are viewed as a period of profound culture crisis and World War I as a radically modernizing force in all areas of English life. A major portion of the writing of this book will be to chart the resistance to and final acceptance of the forces of modernity in English culture during these dramatic years.

General William C. Westmoreland

RESEARCHER: PROFESSOR WILLIAM L. CALDERHEAD

This project was begun early last year with an interview with General Westmoreland. Since then and through this current year, additional information has been gathered from contemporary newspaper, magazine, and journal articles. The first draft (25 pages) has been completed, and it is currently being

revised. New material taken from General Bruce Palmer's association with Westmoreland is being added to the second draft.

This new version should be completed in June, and a copy will be sent to Westmoreland for his comments and approval.

Flag Officers of the Sea Service: Volume I, 1862-1918

RESEARCHER: ASSISTANT PROFESSOR WILLIAM B. COGAR

The volume, to be completed in July 1987, is an edited collection of the careers of every flag rank officer of the U.S. Navy and Marine Corps from 1862 through World War I. As yet there are no reliable works to contain this kind of information. Research has been done primarily from service rec-

ords, then verified from other records. This volume is the first of a projected five-volume work which would take to the present the career summaries and other relevant information on all flag ranks officers of the sea service.

The Souls: High Society and Politics In Late Victorian Britain

RESEARCHER: ASSISTANT PROFESSOR NANCY W. ELLENBERGER

"The Souls" is a study in the social history of the British upper classes at the end of Victoria's reign. It examines a group of some three dozen aristocrats who figured prominently in the social and political life of the nation before the first world war. The work is based on a number of collections of family papers that are still in private hands and that have

not been seen by historians. Using these personal effects, an analysis is made of the ideas, attitudes, and behavior of the group within the context of social, political, and economic changes affecting their class as a whole.

The manuscript is now 300 pages in length, with one chapter and an introduction left to write.

Schooling Girls in Napoleon III's France: Marie Caillard's Reports from the Southwest

RESEARCHER: ASSISTANT PROFESSOR ANNE T. QUARTARARO

This article investigates the material and social conditions of girls' public primary schooling in mid-nineteenth century France as reported by a woman inspector of schools, Marie Caillard. The researcher has used three departments in southwestern France to understand the strengths and weaknesses of girls' popular education. Marie Caillard's reports are a unique source for the historian in the attempt to

reconstruct the problems inherent in the spread of popular education. Caillard's commentary provides insight into the local limitation of primary schooling and the pressure from Paris to invest more money in the education of lower class girls. The article shows how Caillard made innovative suggestions about girl's popular education for her own period.

Women Teachers and Popular Education in Nineteenth Century France: Social Values and Corporate Identity at the Normal School Institution

RESEARCHER: ASSISTANT PROFESSOR ANNE T. QUARTARARO

This research project analyzes the development of women's popular education in nineteenth century France through the normal school institution. By using archival sources in Paris and in the provinces, the researcher was able to study changes in pedagogy and social formation at these teacher training schools. Special attention was given during the course of the study to the normal school as a corporate group that experienced changes in recruit-

ment and organization, but that, nevertheless, upheld continuity in social values throughout the period. The normal schools were designed as a lower-class institution, to promote the education of the common people, but they reinforced certain middle class values among these lower-class women. This book-length manuscript was completed during the 1986-1987 academic year.

The Origins of the Modern American General Staff

RESEARCHER: ASSISTANT PROFESSOR WILLIAM R. ROBERTS

This study underscores the different goals that military leaders sought to achieve through the creation of the Army general staff in 1903. Previous historians have argued that the American General Staff was patterned after European (specifically, Prussian) institutions and was designed solely to make the Army a more effective fighting force. This research, however, has led to the conclusion that the staff reforms introduced at the beginning of the twentieth century also represented the culmination of a long-

standing quarrel within the Army over the duties and importance of staff officers. The creation of the General Staff in 1903 did as much to centralize and strengthen the authority of the Secretary of War over the Army as it did to improve the fighting skills of military men. The General Staff Act of 1903, in short, contributed to the bureaucratization as well as the professionalization of the military establishment.

Isis in Classical Athens

RESEARCHER: ASSISTANT PROFESSOR RONDA R. SIMMS

The Egyptian goddess Isis was worshipped in Athens at least as early as the 330s B.C. The questions this study attempts to answer are: the date of Isis's entrance into Athens; the reasons for the establishment of her cult there; and the extent of citizen involvement. Sources of information included primarily inscriptions, the orators of the fourth century, and archaeological remains. The researcher's general conclusions are that Athenian citizens had little or no interest in this deity as a subject of wor-

ship. They permitted the establishment of her cult in the Piraeus (Athens' port) for economic reasons, i.e., as a favor to Egyptian merchants and resident aliens, both of whom were important to Athenian trade. In the fourth century B.C., trade was vital to the economic health of Athens.

This study was submitted to *The Classical Journal*. It is hoped that this will be the first of a series of articles on the importation of foreign cults into Athens during the Classical period.

Ramus and Reform

RESEARCHER: ASSISTANT PROFESSOR JAMES V. SKALNIK

This project is a book-length study of the transformation of French society in the sixteenth century, seen through the life and works of the humanist and educator Petrus Ramus (Pierre de la Ramee, 1515-1572). The study demonstrates that the meritocratic society of Renaissance France gave way to an oligarchic and hierarchical social order after about 1550, largely due to demographic growth and economic slowdown. The vexing problem of why "Ramism" was so popular in Europe is resolved by showing that Ramus developed an ideology of mer-

itocracy which united many followers in opposition to the prevailing trend toward oligarchy. His efforts to put this theory into practice, although ultimately unsuccessful, constitute crucial chapters in the history of the French Reformed Church and of French education. The study draws extensively on unpublished material in Parisian archives and relies on the techniques of collective biography, computer-assisted analysis of sixteenth-century publication data, and the sociology of ideologies and *mentalites*.

The Last Cavaliers: Horse Cavalry in the Twentieth Century

RESEARCHER: ASSOCIATE PROFESSOR JACK SWEETMAN

Six great changes have occurred on the battlefield in the course of the twentieth century: the appearance of aircraft, armored fighting vehicles, automatic small arms, electronic communications, and nuclear weapons – and the disappearance of horse cavalry, traditionally the most prestigious combat arm. Conventional wisdom holds that World War One revealed cavalry to be an anachronism, but the issue is more complicated than that. Although the arm proved useless in the conditions of trench warfare which prevailed on the Western Front, it was extensively employed in the East, and some of the largest cavalry operations in history – those of the

British Desert Mounted Corps – took place on the Palestine Front in 1917-1918. As late as the outbreak of World War Two, the army of every major power except Great Britain included horse cavalry, and the German army actually had more mounted units at the end of the war than at its beginning. This project will combine operational and institutional history within an essentially chronological framework to examine the technological and tactical developments that led to the gradual extinction of cavalry and the doctrines and means by which it attempted, unsuccessfully, to respond to the challenge these developments posed.

Command of the Sea: The U.S. Navy in Vietnam

RESEARCHER: ASSOCIATE PROFESSOR JACK SWEETMAN

The object of this 7,500-word article is to present a concise history of U.S. Naval operations in Vietnam. Although it centers on the period during which American forces engaged in combat, 1965-1973, its introductory section traces the origins of U.S. Naval involvement in Vietnam back to the activation of the Navy Section of the Military Assistance and Advisory Group, IndoChina, in 1950. The organization is basically chronological. Within this framework, the article reviews the full spectrum of naval

activities in Vietnam, extending from the coastal and riverine missions of the Brown Water Navy to carrier air operations, shore bombardment, amphibious landings, the advisory program, and medical and logistical support. Research in printed materials was supplemented by interviews with officers who served in Vietnam. The project has been completed and the product is to appear in a forthcoming volume of the *Time-Life* Boston Publishing Company series, "The Vietnam Experience."

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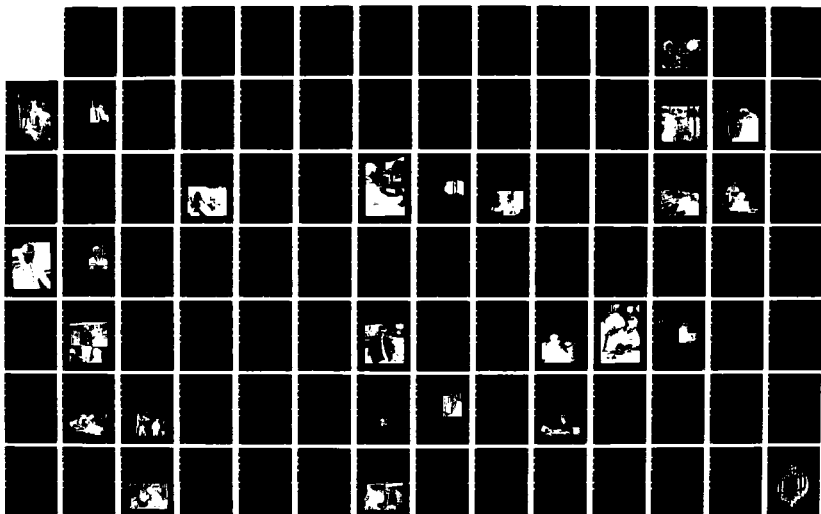
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The U.S. Marine Corps: An Illustrated History

RESEARCHER: ASSOCIATE PROFESSOR JACK SWEETMAN

This work, co-authored with Lieutenant Colonel Merrill L. Bartlett, USMC (Ret), is designed to provide a concise but authoritative history of the U.S. Marine Corps from the foundation of the Continental Marines in November 1775 to the present. The narrative is to follow a chronological format. This researcher will contribute the chapters covering the period up to American intervention in World War One; Colonel Bartlett will contribute the remainder. The division was predicated on the assumption that the personal experience which Colonel Bartlett—twice winner of the Marine Corps Historical Founda-

tion's prestigious Heint Award for the best annual article on Marine Corps history—brings to the project will become progressively more valuable as the narrative nears the present. The projected length is approximately 60,000 words. The work will include humorous, carefully-chosen illustrations along with maps and appendices listing the Commandants of the Marine Corps, Marine Corps Medal of Honor recipients and Battle Streamers. It is anticipated that the project will be completed by late 1987 or early 1988.

A Year on a Monitor

RESEARCHER: PROFESSOR CRAIG L. SYMONDS

Between December 1882 and December 1883, 16-year-old Alvah P. Hunter served as a ship's boy aboard the Union Monitor *Nahant* off the coast of South Carolina. His memoirs of that year form the

body of this volume which the researcher has edited and annotated for publication by the University of South Carolina Press.

Racial Welfare in the Third Reich: The NSV and Social Engineering For a "Gesundes Volksempfinden"

RESEARCHER: PROFESSOR LARRY V. THOMPSON

This article, accepted for publication by the *Journal of Modern History*, examines the racial criteria that governed welfare policies in Nazi Germany. It focuses on the *Nationalsozialistische Volkswohlfahrt* (NSV), the Party's welfare organization, assessing its activities and efforts both to minister to the less fortunate and to raise societal consciousness concerning the absolute need to improve Germany's racial health. The NSV spent the bulk of its time engaged in "institutional warfare" with competitive

agencies of Heinrich Himmler's SS and the German churches. The ideological dictates of racism produced welfare policies and propaganda that challenged religious principles which forced the NSV to be responsive to ecclesiastical concerns. The warfare with the SS never ended, but Himmler's agencies eventually allowed some division of labor to develop, thereby permitting welfare to occur while clearly limiting it to those who were "certified" as racially valuable.

The Construction of the German Imperial Navy 1890-1919

RESEARCHER: ASSISTANT PROFESSOR GARY E. WEIR

This book manuscript is an examination of the naval-industrial relationships in the construction of Germany's Imperial Navy, 1890-1919. The objective is to achieve an understanding of the developing naval-industrial complex in Germany at the turn of the century through World War One.

The research for the project in West German's archives is long since finished. All nine chapters are written, with seven in finished form. Revisions will be completed and the manuscript ready for submission by August 1987.

Research Course Projects

The Soviet-Finnish Winter War: A Political Miscalculation

RESEARCHER: MIDSHIPMAN 1/C THEODORE P. ANDERSON

ADVISER: ASSOCIATE PROFESSOR JANE E. GOOD

This project focused on the Soviet-Finnish winter war of 1939-1940. The research showed that the poor Soviet performance in the war was largely a result of the Communist Party's inability to distinguish between accurate intelligence and its own

propaganda. Research was conducted in English, Finnish, and Russian sources found mainly in the Library of Congress. The paper was presented at the Regional Phi Alpha Theta Conference where it was awarded third place in the undergraduate category.

Command in War: An Analysis of the Compatibility of Execution and Planning

RESEARCHER: MIDSHIPMAN 2/C CHARLES R. BINGHAM

ADVISER: VISITING PROFESSOR NIGEL DE LEE

Two basic functions of command are planning and execution. This project analyzes under which circumstances these functions should be embodied in a single person, or in two people. The researcher supports the conclusion that personality, style, and

ability determine whether a person should plan, execute, or do both. Historical examples used are: Frederick, Napoleon, Grant, Lee, Moltke, Robertson, and Morgan.

Imperialism During the Late Victorian Era: An Analysis of the Perceptions, Attitudes, and Influence of the Working Class, the Financiers and Industrialists, the Press, the Monarchy, and the Middle Class

RESEARCHER: MIDSHIPMAN 1/C CHRISTOPHER CALHOUN

ADVISER: ASSISTANT PROFESSOR NANCY W. ELLENBERGER

The researcher studied the impact of the British Empire on domestic Great Britain during the late Victorian era (1880-1901). Emphasis was placed on the perceptions which various classes in late Victorian society had on the imperial experience. Societal elements studied included the working class, the financiers and industrialists, the press, the monarchy, and the middle and upper classes. The researcher concluded that the primary controlling force behind late Victorian expansion was the governmental apparatus which had grown during the early and middle years of Victoria's reign. This apparatus, although influenced by the monarchy and by

the financiers, remained ultimately in the control of the middle and upper classes, which provided the backbone of the civil servicemen, military, and political leaders. Least influential of the societal elements studied was the working class, which because of disunity and lack of dynamic leadership, proved unable to have any impact on the course of imperial expansion during this era.

The research included both primary and secondary source material drawn from periodicals, historical accounts, political treatises, letters, and an interview with a published expert in the field of study.

The Fractured Society: An Analysis of the Divergence of White South Africa Along Language Lines, 1900-1948

RESEARCHER: MIDSHIPMAN I/C CHRISTOPHER CALHOUN

ADVISER: ASSOCIATE PROFESSOR THOMAS BRENNAN

This project is a study of the developments in white South African society during the first half of the twentieth century. An emphasis was placed on how the two main elements of this society might have joined together in a cooperative effort to resolve their state's pressing social problems. Cooperation did not survive in the long run, leading to Afrikaner political domination and the near complete exclusion of English South Africans from governmental affairs since 1948. High points in the unsuccessful efforts to bring about a union of the two white streams of South African society included the era of Conciliation and the South African Party (1908-1914), the Labour-National Party Pact (1924-1929), and the early successes of the United South African

National Party (1933-39). Divisive events which set back the cause of white unity included South African participation in the two world wars, and class conflict which roughly followed language lines.

Research material for this project included both primary and secondary source material from American and British periodicals, South African, British, and American historical accounts, and biographies and letters of South African political leaders. The paper concluded that white South Africa's failure to unify and compromise—which further complicated the nation's already dire social and racial problems—involved class as well as nationalistic conflicts.

The Leaders of World War II

RESEARCHER: MIDSHIPMAN I/C KENNETH L. CLARK

ADVISER: ASSOCIATE PROFESSOR KENNETH J. HAGAN

This research project was done to delineate the factors which differentiate men of high positions into successful and unsuccessful groups.

One by-product of a wartime environment is a large number of leaders who are forced to make decisions of global importance under the most trying circumstances. This high-pressure environment tends to bring out the best and the worst traits of each leader. This fact, in combination with the need to examine leaders who faced similar difficulties, led the researcher to choose World War II as the period of interest for this project.

The inter-personal relationships which all leaders face require the examination of several different topics to establish a reasonable basis for the determination of whether a particular leader is, or is not,

successful. The themes that are presented in the paper are that:

(1) personality conflicts between high-level decision-makers, as well as an individual's personal ambition, often affect decisions of life and death importance;

(2) all great leaders possess traits such as charisma, courage, devotion to duty, innovativeness, optimism, and imagination, as well as egoism and ambition; and

(3) the most successful of these leaders have the desire and ability to understand the culture of foreign peoples, as well as a concern for the future beyond the present conflict and beyond their future personal involvement.

A Study in Contrasts: The Constitutional Convention of 1787 as Viewed by the Press in Philadelphia and Annapolis

RESEARCHER: MIDSHIPMAN 2/C JANE M. COLLINS

ADVISER: PROFESSOR JOHN W. HUSTON

The purpose of this project was to study the role of the press during the Constitutional Convention of 1787. Research was focused on the *Maryland Gazette* of Annapolis and the *Pennsylvania Gazette* of Philadelphia, chosen because of the demographic diversity of the subscribers and areas served, as well as the availability of these two newspapers on microfilm. The two papers were shown to have covered

the secret proceedings of the convention very differently. The contrast between the two coverages was attributed to the difference in their geographic locations and the differences in their subscribers (rural versus urban), among other factors. The influence of the press on the young country's citizens was analyzed, as it was to have an effect on the ratification struggle that followed the convention.

The German U-Boats of World War Two: Lessons on the Trans-Atlantic Link

RESEARCHER: MIDSHIPMAN 1/C RODNEY G. GRAVES

ADVISER: VISITING PROFESSOR NIGEL DE LEE

This paper examines the German U-Boat offensive of the Second World War. In so doing, it is revealed that the German U-Boats nearly starved Great Britain out of the war, and that Admiral Doenitz approached this monumental task with a very small force of operational submarines.

Particular emphasis is placed on the following areas: First, the tactics employed by the Germans and the evolution of these tactics are examined in light of Allied counter tactics. Second, the paper examines the course of the U-Boat war at sea and

its successes and failures against allied shipping. Third, the paper examines the political restraints which prevented Admiral Doenitz from employing his U-Boats in the best tactical and strategic manner.

The final portion of the paper touches on the disastrous PQ (England to Murmansk) convoys which were under the combined threats of submarine, air, and surface attack, and relates this to the evolution of the modern nuclear submarine and the threat expected in a current battle of the North Atlantic.

Norway and Soviet Union: Conflict and Coexistence in the Arctic

RESEARCHER: MIDSHIPMAN 1/C RODNEY G. GRAVES

ADVISER: VISITING PROFESSOR NIGEL DE LEE

This project examines the history of relations among Norway, NATO, and the Soviet Union, with particular emphasis on the emergence of northern Norway as the vital northern flank of both NATO and the Soviet Union. Subtopics include surveys of the history of Norway in the First and Second World Wars, the emergence of Norwegian foreign and defense policies, and an examination of incidents between the Norwegian and Soviet governments. The

increasing and changing nature of the strategic situation in the area is examined in some length and is related to local history and perceptions. The last portion of the paper is an examination of Norway's involvement in NATO, discussed in terms of Norway's need to balance its foreign and defense postures, offering a real deterrent to armed aggression without antagonizing the Soviet Union.

An Examination of the World of Terrorism

RESEARCHER: MIDSHIPMAN 1/C BRIAN E. HALEY
ADVISER: LIEUTENANT COMMANDER DON T. SINE, USN

This research project was designed to supplement a readings course which was organized around the topic of terrorism. The objective for writing this paper was to coalesce the information gained in the readings part of the course. In writing this paper, the researcher came to understand better the motivations and objectives of modern terrorism. In addition it became evident that terrorism has been

present in society since the inception of the nation state. Moreover, it became apparent that the difficulty in combatting contemporary terrorism may only get harder as technology advances. Research for this topic was accomplished using the facilities available in the Nimitz Library and in Defense Technical Information Center (DTIC) publications of the Rand Corporation Conferences concerning terrorism.

The Relation of Homeric Mythology to Homeric Self-Perception

RESEARCHER: MIDSHIPMAN 1/C ERNEST A. HARPER
ADVISER: ASSOCIATE PROFESSOR PHYLLIS CULHAM

This project was inspired by a broad interest in Greek mythology, but through initial research the focus of the paper was narrowed to Homeric society, specifically that represented in the epic poem, *The Iliad*. The poem itself served as the primary source for the research, and various authorities on ancient society and mythology, such as Bruno Snell, were utilized as secondary sources.

The thesis of the paper is that Homeric man's perception of the origin of important human actions

lay not within himself, but with the gods. The paper examines this suggestion from an evolutionary standpoint, using the Mycenaean civilization as a foil against which Homeric values and ideals are established. Next, the immortality of the gods is discussed, with particular emphasis on reasons for divine immortality versus human mortality. Finally, evidence from *The Iliad* itself is offered in support of the thesis.

Chet Smith and *The Swordfish*: First Blood in the Pacific

RESEARCHER: MIDSHIPMAN 1/C J. STUART HAYDEN
ADVISER: ASSOCIATE PROFESSOR KENNETH J. HAGAN

This project included significant independent research conducted during the Spring Semester of the 1985-1986 Academic Year. The primary sources were found at the Naval Historical Center Operations Archives Branch and also at the Military Reference Branch of the United States National Archives, both in Washington, D.C. The experience of locating and studying such valuable documents was definitely unique.

Chester C. Smith, a native of Idaho and a 1925 graduate of the U.S. Naval Academy, was the commander who led the *Swordfish* to sea and to victory. Under his leadership, *Swordfish* was the first U.S. submarine to get underway following the Japanese attack on Pearl Harbor. In addition, she was

first to attack and sink an enemy vessel, first to withstand a depth charge attack, and also first finally to have a sinking confirmed by the enemy. Chet Smith and the *Swordfish*, by taking the war to the enemy's home waters, helped return confidence to the U.S. Navy and the nation. While America was recovering from the shock of Pearl Harbor and gearing-up for the war, Chet Smith was already launching torpedoes and punishing the Japanese. The adventures of this first war patrol were heroic and truly remarkable. This paper is written on the forty-fifth anniversary of the patrol and in memory of those men of the *USS Swordfish* "still on patrol."

An Examination of Technological Innovation In the Modern Age: Critiques and a New Perspective

RESEARCHER: MIDSHIPMAN 2 C DANIEL J. HURDLE

ADVISER: ASSOCIATE PROFESSOR ROBERT ARTIGIANI

This research project was conceived as a means of better understanding the effect of technological innovations on modern society. The process of rapid technical development and subsequent societal implementation has not been a smooth one in recent times. Issues concerning self-regulating robotics versus manual labor and the threat of nuclear weapons are prime examples, and one has little trouble today recognizing the major importance now attached to this technical adaptation question.

The first portion of the project was devoted to studying works of those critical of the technical advance in the modern age. Numerous authors, including Ellul, Winner, Wells, and Junger, described what they perceived as an all-powerful and autonomous technology that was sure to dominate completely all aspects of society. Subordination of all that is humanistic in favor of a completely rational, ordered world would be inevitable in the face of this technical "onslaught."

The researcher then analyzed both a possible explanation and solution to the modern technical

dilemma. A new cognitive map offered by Ilyad Prigogine and others supersedes the Newtonian deterministic and mechanistic equilibrium-oriented approach, which has predominated modern thought, with one that emphasizes evolving, non-equilibrium systems which are possibilistic in nature. Much of modern technology, e.g. cybernetics and nuclear power or bombs, stems directly from this cognitive map. Thus, it follows that problems in societal adaptation to technological innovations may be caused not by the nature of technology but by the use of the wrong cognitive map.

Finally, the project studied the General System Theory offered by Bertalanffy which incorporates the Prigogine approach. The system theory was found to have exciting potential in its ability to offer generalized approaches to the analysis of numerous types of systems, whether purely technical or predominantly human, and as a means of enabling society successfully to incorporate the technology it produces.

Dating the Shift in Strategy from Battleship Theory to Carrier Battlegroup

RESEARCHER: MIDSHIPMAN 2 C MICHAEL R. LOWE

ADVISER: ASSOCIATE PROFESSOR KENNETH J. HAGAN

This research paper utilized sources from the Nimitz Library as well as the Washington Navy Yard. The most important sources were found at the Naval Historical Center. Using these sources, the researcher concluded that it is possible to date precisely the United States Navy's shift in strategy from one based on traditional battleship theory to one based on the

carrier battlegroup. The change occurred primarily after the battles of the Coral Sea and Midway, and specifically between September 1942 and July 1943. Correspondence between Admiral Nimitz, Admiral King, and the fleet commanders in the Pacific provided the information necessary to support this conclusion.

A World War II Enlisted Sailor's Memoirs of the European Theater of Operations

RESEARCHER: MIDSHIPMAN 1 C THOMAS A. MCKENNA
ADVISER: LIEUTENANT COMMANDER DON T. SINE, USN

This research project was designed to allow the researcher to make use of a first-hand account of an enlisted sailor's experiences during the invasion of North Africa and the invasion of Italy. The project was to read the manuscript and prepare it for publi-

cation. The research also included finding various sources which could compare and contrast the viewpoints of the war from an enlisted and officer perspective.

Nazi Governance: An Inquiry into the Controversy over Executive Responsibility In the Third Reich

RESEARCHER: MIDSHIPMAN 1 C MICHAEL L. SPANOS
ADVISER: PROFESSOR LARRY V. THOMPSON

This research project examines the dictatorship of Adolf Hitler, discussing whether he was a weak or strong dictator. This question is the focus of a heated and ongoing debate between historians of National Socialism which has spawned two rival factions, known categorically as functionalists and intentionalists. The functionalist position, favoring the "weak" dictator theory, and the intentionalist viewpoint, promoting the "strong" dictator principle, are analyzed for the purpose of delineating their respective strengths and weaknesses.

Through analysis of this controversial issue, cer-

tain policies and structures of the Nazi government are highlighted. Hitler's increasing concern for the German people instead of the Nazi party, his racial war of genocide, the *Fuehrer's* insistence on governmental centralization, yet his toleration of executive and administrative decentralization, and his foreign policy goals are the focus of research. The researcher concurs with the functionalist viewpoint. Although Hitler's power as a ruler is not denied, it proved surprisingly feasible for the National Socialism system to anticipate and prosecute policy with or without *Fuehrer* approval.

Publications

BOGACZ, Theodore W., Associate Professor, "A Tyranny of Words: Language, Poetry and Anti-modernism in England in the First World War," *Journal of Modern History*, 58, 3 (September 1986), 643-668.

In this article an analysis is made of the language widely employed by civilians in England to depict the Western Front during the First World War. Characterized by abstractions and euphemisms, this "high diction" was a singularly inappropriate vehicle for depicting the brutal realities of modern war. This language sprang from the tens of thousands of civilian "war poems" which in 1914 celebrated war as an ennobling pageant in which virtuous "knights" sacrificed themselves for their nation. But the Western Front was not Agincourt. By November 1914, an ironic reversal of civilian expectations had occurred. The struggle in France had become a war of attrition dominated by machine guns and artillery in which individual "valour" mattered little. High diction was incapable of encompassing this horrific vision of modern mechanized warfare. Why then did it persist in the English press right up until the Armistice? Civilian ignorance does not explain this persistence: the article demonstrates that the truth of the Western Front was widely known among civilians by early 1915. Instead, it stressed the widespread antimodernist tendencies in English culture as an answer. By use of it, English civilians could ignore or obfuscate the crises arising from democratization and industrialization and maintain, instead, that traditional values still survived. The article concludes by assessing the efforts of some soldiers and civilians to create a new language which could encompass not only the realities of modern war but of the modern world as well.

COGAR, William B., Assistant Professor, "History at the Naval Academy," *The Consortium on Revolutionary Europe Proceedings*, (1986) pp. 110-115.

This paper, in conjunction with other papers from the Air Force Academy, West Point, and the Naval and Army War Colleges, discussed the role of history curriculum in a military institution of higher learning, with special emphasis on the role of revolutionary European history. The entire curriculum requirements were explained, the History Major in particular, then specialized courses on European history and especially the period from 1763-1815.

CULHAM, Phyllis, Associate Professor, "Social Science Approaches to the Study of Women in Antiquity: A Bibliography of Bibliographies," *Women's Classical Caucus Newsletter*, 11 (Spring 1986), 9-11.

The article is a compilation of items from the fields of anthropology, sociology, psychology, and women's studies which discusses the kinds of references to be found in each source and explains their utility for the classicist.

CULHAM, Phyllis, Associate Professor, "Again, What Meaning Lies in Colour!" *Zeitschrift für Papyrologie und Epigraphik*, 64 (1986), 235-245.

The paper suggests that recent discussions of ancient Greek cultic restrictions on adornment and of Roman sumptuary laws fail to account for the phenomena they discuss, because they do not consider the Greek and Roman evidence together. This has led to the widespread adoption of the false beliefs that restrictions on apparel were anomalous rather than ubiquitous in the Greek world and that Roman sumptuary legislation was economically motivated. An approach derived from Turner's social anthropological work on *communitas* applied to both sets of data reveals many similarities between the Greek cultic restrictions and the Roman legislation, demonstrates that the Roman legislation was not economic in effect or intent, and argues that the true purpose of such regulations in both Greece and Rome was to eliminate or channel socially disruptive competition for status.

CULHAM, Phyllis, Associate Professor, "Ten Years After Pomeroy: Studies of the Image and Reality of Women in Antiquity," *Helios*, 12 (1986), 9-30.

This methodological essay opens a special issue of *Helios* devoted to the study of women in antiquity (which will be published under the title *Rescuing Creusa* in hardback and paperback by Texas Tech Press). It analyzes the cultural origins of modern methodologies and assumptions applied to the study of women in antiquity and assesses their prospects for success. It examines the utility of different methods when applied to varying sorts of data, and claims that classicists to date have relied too extensively on structuralist and poststructuralist methodologies while neglecting materialist approaches.

MASTERSON, Daniel M., Associate Professor, Editor, *Naval History: The Proceedings of the Sixth Naval History Symposium*, Wilmington, Delaware: Scholarly Resources Publishers, 1987.

This volume contains more than thirty of the papers presented by naval history scholars at the Sixth Naval History Symposium held at the Naval Academy in the Fall of 1983. These studies range from papers on ship design and biography to an analysis of naval medical support operations during World War II. The History Department faculty assisted in the editing of this volume.

PEELER, David P., Assistant Professor, "American Parties: Shifting from First to Second," *Canadian Review of American Studies*, 17 (Summer 1986), 201-210.

This article reviews recent scholarship on the early national period in the United States. This scholarship all pertains to the shift in American politics that occurred in the 1830s and 1840s, a shift that left many disturbed and others only marginally enfranchised.

PEELER, David P., Assistant Professor, *Hope Among Us Yet: Social Criticism and Social Solace in Depression America*. Athens, Georgia: The University of Georgia Press, 1987.

This book examines art and literature of the Great Depression, illustrating a common pursuit and a common dream in the work of writers, photographers, and painters who turned their talents toward the dislocation and despair of the 1930s. Thrust out of the gilded world of the 1920s by the extent of the crisis, these artists used their canvases, cameras, and pens to condemn injustices within America. As the years drew on, though, they began to dream of a new, more equitable social order, and the solace of those dreams, rather than their earlier vilification, came to dominate Depression art.

PEELER, David P., Assistant Professor, "Thomas Jefferson's Nursery of Republican Patriots: The Univer-

sity of Virginia," *Journal of Church and State*, 28 (Winter 1986), 79-93.

Thomas Jefferson was the founder of the University of Virginia. In part he acted as an Enlightenment man who believed that reason, and especially the trained mind, could plumb the workings of the universe and human society. But Jefferson had other motives for erecting the University; he hoped that it would take the nation's future leaders and steep them in the principles of his Republican Party. This article analyzes the amalgam of motives that led to Jefferson's founding of the University.

SKALNIK, James V., Assistant Professor, co-author, "Slavery: Annual Bibliographical Supplement (1985)," *Slavery and Abolition: a Journal of Comparative Studies*, 7 (December 1986), 315-388.

A supplement to Joseph C. Miller's *Slavery: A Worldwide Bibliography, 1900-1982*, continues the updated coverage of Skalnik and Miller, "Slavery: Annual Bibliography Supplement (1984)," *Slavery and Abolition* 6 (May 1984), 59-92. The bibliography includes "secondary writings published on slavery or the slave trade anywhere in the world since 1900 in western European languages," and covers slavery in all societies from the ancient world to the present day.

SWEETMAN, Jack, Associate Professor, *The Landing at Veracruz: 1914*. Annapolis, Maryland: Naval Institute Press, 1987.

Drawing upon archival materials, published sources, and interviews and correspondence with veterans of the operations, this work presents a detailed account of the seizure of Veracruz, Mexico, by seamen and Marines of the U.S. Atlantic Fleet on 21-22 April 1914. It also contains a concise survey of the diplomatic background and eventual resolution of the crisis, brought about by President Woodrow Wilson's self-professed determination "to teach the South American republics to elect good men." *The Historian* described the book as "an excellent study on a highly personal level of a nearly forgotten incident in American naval history which deserves to be remembered." It was originally published in 1968.

SWEETMAN, Jack, Associate Professor, Series Editor, "Classics of Naval Literature," Naval Institute Press.

This series, inaugurated by the Naval Institute Press in 1984, is designed to provide attractive new editions of classic works of naval history, biography, and fiction. In addition to the unabridged, original text, each work includes a substantial introduction and, when appropriate, explanatory notes by an expert in the field. Some editions also contain new illustrations and maps. The following works appeared during this reporting period:

Fred J. Buenzle with A. Grove Day, *Blue-jacket: An Autobiography*. Introduction and notes by Professor Emeritus Neville T. Kirk.

Filson Young, *With the Battle Cruisers*. Introduction and notes by Lieutenant James V.P. Goldrick, Royal Australian Navy.

Herman Wouk, *The Caine Mutiny*. Introduction by Lieutenant Commander Noel A. Daigle, USN.

George Dewey, *Autobiography of George Dewey, Admiral of the Navy*. Introduction and notes by Eric McAllister Smith.

SWEETMAN, Jack, Associate Professor, Consulting Editor, *Naval History* magazine, 1, 1 (April 1987).

This is the premier issue of a new journal of naval history published by the U.S. Naval Institute. Its contents, ranging over the entire field of American and foreign naval history, include articles on the Brown Water Navy in Vietnam, submarine and anti-submarine operations in World War II, the flight of the NC-3 and a recent reenactment, German gunboats on the Yangtze, naval historiography, the U.S. Coast Guard's Ocean Stations program, the Battle of Wake Island, the foundation of the Russian Navy by Czar Peter the Great, and U.S. Naval aviation on the Italian front in World War I. Among the magazine's departments section is an "In Progress" feature containing reports on the current activities of the historical offices of the U.S. Navy, Marine Corps, and Coast Guard, as well as the Naval Institute. Quarterly publication is to commence in 1988.



Presentations

ABELS, Richard P., Associate Professor, **"England's Grand Strategy in the 9th and 10th Centuries and the Viking Invasions,"** New England Conference, University of New Hampshire, Durham, New Hampshire, 25 October 1986.

ABELS, Richard P., Associate Professor, **"Barbarian Christianity,"** Unitarian Fellowship of the Eastern Shore, Easton, Maryland, 15 February 1987.

ABELS, Richard P., Associate Professor, **"Bede, Beowulf and the Early English Church,"** Columbia University (Graduate School Renaissance Medieval Seminar), New York, New York, 22 March 1987.

ARTIGLIANI, P. Robert, Associate Professor, **"A Dissipative Structure Model of Scientific Revolution,"** Turning Points in Time Conference, Les Treilles, France, 3-9 July 1986.

ARTIGLIANI, P. Robert, Associate Professor, **"Intentionality and Selection: On the Nature of Cultural Evolution,"** Society for Human Ecology, Bar Harbor, Maine, 15-17 October 1986.

ARTIGLIANI, P. Robert, Associate Professor, **"Cultural Evolution,"** Physis: Abitare la Terra, Florence, Italy, 25-30 October 1986.

ARTIGLIANI, P. Robert, Associate Professor, **"Of Tools and Butterflies,"** Technological Innovation and Institutional Adaptation, U.S. Naval Academy, Annapolis, Maryland, 15-17 March 1987.

ARTIGLIANI, P. Robert, Associate Professor, **"The Favored Many Model: An Evolutionary Guide to Societal Development,"** International Society for General Systems Research, Budapest, Hungary, 2-7 June 1987.

ARTIGLIANI, P. Robert, Associate Professor, **"Science, History, and Humanism,"** Washington Evolution Club, Washington, DC, 21 June 1987.

BOGACZ, Theodore W., Associate Professor, **"The Lessons of Shell-Shock,"** War Discussion Group, The Royal Military Academy, Sandhurst, England, 24 November 1986.

BRENNAN, Thomas, Associate Professor, **"The Social History of Alcohol in France,"** Conference on the Social History of Alcohol, Gainesville, Florida, 12-15 March 1987.

CALDERHEAD, William L., Professor, **"America's Long Forgotten Dueling Ground: Bladensburg, Maryland, 1809-1860,"** Conference of the Northern Great Plains History Association, Eau Claire, Wisconsin, 26 September 1986.

CALDERHEAD, William L., Professor, **"Operations of the French Fleet in American Waters During the Summer of 1778,"** Annual Dinner Banquet of the American Revolutionary War Round Table, Fort Myer, Virginia, 1 April 1987.

CULHAM, Phyllis, Associate Professor, **"Texts, Pretexts, and Contexts: Recourse to Documentation in Republican Rome,"** Annual Meeting of American Philological Association, San Antonio, Texas, 30 December 1986.

CULHAM, Phyllis, Associate Professor, **"Concepts of Citizenship in the Classical World,"** Conference on Citizenship and the Bicentennial of the Constitution, Annual Meeting of the Virginia Humanities Conference, Randolph Macon College, Ashland, Virginia, 14 April 1987.

CULHAM, Phyllis, Associate Professor, **"Sibyl: Hellenistic Judaic Tradition and Italian Topography,"** Unitarian Fellowship of the Eastern Shore, Easton, Maryland, 12 October 1986.

CUTLER, Thomas L., Lieutenant Commander, USN, **"Vietnam In The Classroom: The Veteran Teaching Tomorrow's Veterans,"** American Cultural Association Meeting, Montreal, Canada, 27 March 1987.

DECREDICO, Mary A., Assistant Professor, **"Urban Entrepreneurs in the Civil War South,"** Social Science History Association Annual Meeting, St. Louis, Missouri, 17 October 1986.

ELLENBERGER, Nancy W., Assistant Professor, **"Their Last Hour Sounded: Aristocrats and Mass Democracy at the End of the Nineteenth Century,"** Western Conference on British Studies, Denver, Colorado, 11 October 1986.

HUSTON, John W., Professor, **"Research, History and the USNA Library,"** Library Staff, Nimitz Library, U.S. Naval Academy, Annapolis, Maryland, 21 June 1986.

HUSTON, John W., Professor, **"World War II Leadership,"** Air War College and Air Command and Staff College, Air University, Maxwell Air Force Base, Montgomery, Alabama, 25 August 1986.

HUSTON, John W., Professor, **"Leadership in the Air in World War II,"** Air Force Convention, Washington, DC, 19 September 1986.

HUSTON, John W., Professor, **"Maryland and the Constitution,"** Anne Arundel County Bar Association, Annapolis, Maryland, 7 October 1986.

HUSTON, John W., Professor, **"George Washington and Maryland,"** St. John's College Lecture Series, Annapolis, Maryland, 17 February 1987.

HUSTON, John W., Professor, **"Challenges of Leadership,"** Sixth Company Mess Night, U.S. Naval Academy, Annapolis, Maryland, 13 March 1987.

HUSTON, John W., Professor, **"Fort Pitt and the French and Indian War,"** Colonial Wars Society, Baltimore, Maryland, 25 March 1987.

HUSTON, John W., Professor, **"George Washington, An Assessment,"** Maryland Questers Club, Annapolis, Maryland, 9 April 1987.

HUSTON, John W., Professor, **"Jonas Green, Annapolis Printer,"** Kiwanis Club of the Severn, Annapolis, Maryland, 14 May 1987.

HUSTON, John W., Professor, **"Reassessing the U.S. Constitution,"** Daughters of the American Revolution, Fort Severn, Maryland, 19 May 1987.

HUSTON, John W., Professor, **"Reassessing the Air Force Heritage,"** Virginia State Meeting of Air Force Association, Charlottesville, Virginia, 22 May 1987.

LOVE, Robert W., Associate Professor, **"Maritime Access and the Falklands Crisis in the Age of Jackson,"** Citadel Conference on War and Diplomacy, Charleston, South Carolina, 10 October 1986.

PEELER, David P., Assistant Professor, **"Minor White and The Mystic War,"** Baltimore Museum of Art, Baltimore, Maryland, 21 September 1986.

PEELER, David P., Assistant Professor, **"Unknown Territory: Ray K. Metzker,"** National Museum of American Art, Washington, DC, 10 October 1986.

SYMONDS, Craig L., Professor, **"The Civil War in Maryland,"** St. John's College, Annapolis, Maryland, 30 March 1987.

THOMPSON, Larry V., Professor, **"The SS as the 'State' of the Future Under National Socialism,"** German Historical Institute, London, England, 17 October 1986.

Division of Mathematics and Science



DEPARTMENT OF

Chemistry

PROFESSOR CHARLES F. ROWELL
CHAIRMAN

The growth of new knowledge is the result of persistent effort on the part of researchers. This dedication carries with it a sense of excitement which illuminates the classroom as well.

Publication in the open literature (21 papers), presentations at scientific meetings (26), and collaboration with scientists, both in this country and abroad, are symptomatic of growing recognition and stature for the Department. There is a healthy mix of practical Navy problems and more esoteric fundamental research. Student participation in research courses was low due to competition from some exciting new special topics courses, but research interest is keen among upperclass midshipmen.

With five new assistant professors expected in the fall of 1987, we expect the excitement to continue to grow.



Sponsored Research

Effect of Phosphine and Phosphite Ligands on the Chemistry of Arene Chromium Carbonyl Complexes

RESEARCHER: ASSOCIATE PROFESSOR THOMAS E. BITTERWOLF

SPONSOR: NATIONAL RESEARCH COUNCIL OF ITALY

Arene chromium tricarbonyl compounds are receiving considerable attention because of their potential to serve as intermediates in the synthesis of complex organic compounds. Introduction of a chromium tricarbonyl onto an aromatic ring alters the chemical behavior of the ring, so that nucleophilic substitution reactions can be conducted under mild conditions. The present research is directed toward an understanding of the consequences of introducing electron donating groups onto the chro-

mium atom, so that the electron density alterations of the arene ring are fine-tuned.

This joint collaborative project between the USNA and the University of Padova is entering its fourth year and has resulted in significant progress in the study of haptotropic rearrangements of chromiumcarbonyl-substituted fluorene compounds and the generation of previously unknown anions and dianions of compounds containing two chromium groups.

Matrix Isolation Photochemistry of Organometallic Compounds

RESEARCHER: ASSOCIATE PROFESSOR THOMAS E. BITTERWOLF

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

Chemical reactions in which high energy light is used to generate reactive intermediates are called photochemical reactions. In organometallic chemistry these kinds of reactions are particularly valuable, because they can be used to generate new compounds which cannot be obtained by other routes. Much of the preparative chemistry being conducted at the Naval Academy uses photochemical reactions

as a critical part of the process. This high dependence on photochemistry has compelled us to initiate a program of investigation directed toward examining the intermediates generated by photolysis. In collaboration with Professor Anthony Rest of The University, Southampton, England, we have begun an examination of the intermediates formed in several reactions.

Determination of Lubricating Oil Antioxidants by Voltammetry at Microelectrodes

RESEARCHER: ASSOCIATE PROFESSOR GRAHAM T. CHEEK

SPONSOR: NAVAL RESEARCH LABORATORY

Initial work in determining antioxidant levels in lubricating oil (Hercolube) involved observation of the oxidation of diphenylamine, phenylnaphthylamine, and phenothiazine in this nonpolar medium. It was found that addition of tetrahexylammonium benzoate to the Hercolube solutions was necessary in order to produce solutions possessing adequate conductivity for even the very small electrodes (10 μ m diameter) employed in these studies. The oxidation processes were sufficiently well-defined to allow measurement of the amount of phenothiazine, as well as the combined amounts of diphenylamine and phenylnaphthylamine. Although this method gave fairly good results, the solutions involved are very viscous, and addition of the salt is difficult and time-

consuming, considering that the salt is commercially available as an oil and contains considerable amounts of impurities. Another method, involving addition of the Hercolube solutions to acetonitrile (1:10 volume ratio, Hercolube: acetonitrile), was also explored and was found to give better results, probably because the conductivity of acetonitrile solutions is generally good enough to allow meaningful voltammetric results to be obtained without the addition of supporting electrolyte. This method led to the recording of voltammograms which were more clearly defined than those obtained with the previous method. It is estimated that levels of diphenylamine and phenylnaphthylamine can be determined down to the low ppm level with this method.

Spin Trapping In Ordered Media

RESEARCHER: ASSISTANT PROFESSOR EDWARD R. DAVIS

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

The chemistry of the Spin Trapping Reaction was studied using SDS (Sodium Dodecyl Sulfate) micelles as the ordered media. These micelles are used as a model for a cell membrane. The reactivity of the phenyl radical adding to a site of unsaturation was compared in aqueous, organic, and micellar

media. A number of different spin traps were used in this study. The hydroxy radical behaved in an unpredictable and very rapid manner when used in the above described experiment in place of the phenyl radical.

Bonding Modes and Reactivities of Compounds With β -Ketosulfoxide Ligands

RESEARCHER: ASSISTANT PROFESSOR DOUGLAS S. DUDIS

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

Due to the negative charges and chelating ability of β -ketosulfoxides, it is predicted that they would have different properties from simple sulfoxides when included in metal complexes. The asymmetry of these ligands offers additional intriguing possibilities in terms of isomer formation. No good examples

of this system exist, so the preparation and physical characterization of this class of compounds offer a significant opportunity to explore new chemistry. Preparation of intermediates and determination of reaction conditions have been successful to date.

Properties of Helical Polyacetylene

RESEARCHER: ASSOCIATE PROFESSOR MARK L. ELERT

SPONSOR: NAVAL RESEARCH LABORATORY

The recently discovered helical isomer of polyacetylene (an electrically conducted polymer) is poorly characterized experimentally. The researcher has undertaken calculations to determine the equilibrium geometry, electronic properties, and crystal packing of helical polyacetylene (HPA) chains.

The conformation of isolated HPA chains was investigated by performing semiempirical MNDO electronic structure calculations with full geometry optimization for finite chain segments. Oligomers containing up to 24 carbon atoms were considered. The optimum geometry was found to be very close to a perfectly periodic structure, with six (CH) groups per helix turn and a unit cell length of 4.84 Å.

The electronic structure of infinite HPA chains at the predicted equilibrium geometry was cal-

culated, using a tight-binding model. The band gap was found to be in excess of 4 eV, making this isomer unsuitable for applications requiring high conductivity.

The crystal structure of HPA was determined by performing an intermolecular energy minimization as a function of inter-chain distance and helix setting angle for rigid HPA chains on a hexagonal lattice, using standard van der Waals potential energy interaction parameters. The predicted unit cell parameters are very close to the experimental values determined by x-rays diffraction. The packaging energy per (CH) unit is comparable to that found for the planar isomer, demonstrating the helix formation might be favored during acetylene polymerization under appropriate reaction conditions.

Gas Entrainment in Hydraulic Fluids

RESEARCHER: ASSOCIATE PROFESSOR FRANK J. GOMBA

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The presence of dissolved gas in hydraulic fluid provides numerous hazards. These range from formation of bubbles at high temperatures with loss of hydraulic response to chemical attack on the material used as the hydraulic fluid. Determination of the amounts of such gases present in hydraulic fluids therefore represents a significant practical goal. As a way of defining the limits of such solubility, a

laboratory study of the solubility of air and helium is desirable. Two methods of measurement had been proposed and were to be evaluated as to feasibility. Neither of the initial proposals were found to be feasible. Some theoretical calculations were made to define the probable range of values and several alternative methods were suggested.

A Study of Factors Affecting Flames

RESEARCHER: PROFESSOR SAMUEL P. MASSIE

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LIBRARY

As ship construction includes more plastic materials which give off deadly fumes, rather than burn, it becomes more necessary to understand the chemical nature of the smoke, soot, and other aspects of the combustion.

A study was made of some of these factors. The primary method of research involved the preparation of a container from these synthetic materials, burning fuels, especially hexane, and examining the temperatures reached and the nature of the flames.

Determination of the Effects of Time, Temperature, Contaminents, and Oil on Oxide Formation on Navy Babbitt Metal

RESEARCHER: PROFESSOR JOHN W. SCHULTZ

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
ANNAPOLIS LABORATORY

Babbitt metal is an alloy used in bearings for drive shafts and other crucial points in the propulsion systems of Navy ships. Any process that degrades the performance of such bearings reduces the readiness and speed of vessels. Prevention of the for-

mation of the hard coating of tin oxide that forms under some operating conditions requires knowledge of the environmental parameters which affect its formation.

Haptotropic Rearrangement of Fluorene Chromiumdicarbonyl Phosphine Compounds

RESEARCHER: ASSISTANT PROFESSOR JOYCE E. SHADE

SPONSOR: NATIONAL RESEARCH COUNCIL OF ITALY

Organic compounds such as anthracene, phenanthrene, and a fluorenyl anion are multicarbon compounds consisting of fused carbon rings. There exist in these compounds two distinct aromatic centers, through which a transition metal-containing substituent might be bound. In several systems, it has been determined that the metal can migrate from one aromatic center to the other, since this migration is known to have a small activation barrier. In chromiumtricarbonyl systems, for example, which are bound to fluorene, the metal is bound to the normal six-membered ring. Upon removal of one of the methylene hydrogens, a fluorenyl anion is generated, and there is migration of the metal to the newly formed five-membered ring.

The researcher is investigating the effect on the

metal migration between the two aromatic rings as the identity of the ligand substituents on the metal itself is varied. One method for measuring such an effect is to introduce a phosphine or phosphite ligand onto the metal in place of a carbonyl group. Phosphorous-containing ligands are known to affect directly the amount of electron density on the metal, which in turn affects the bonding preference of the metal for the different ring systems. A series of fluorenechromiumdicarbonyl-phosphine derivatives has been prepared. These compounds were sent to Italian researchers at Padova, where the haptotropic rearrangement studies were conducted. The Italian group also collected spectral data on the compounds prior to the rearrangement studies, as well as during and after the studies.

Matrix Isolation Photochemistry Studies of Organometallic Complexes

RESEARCHER: ASSISTANT PROFESSOR JOYCE E. SHADI
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

Photolysis of carbonyl-cyano-isocyanide complexes in the presence of a potential ligand result in the loss of the carbonyl group from the starting material and inclusion of the ligand species present in the reaction mixture. A variety of incoming ligands have been investigated and very interesting results have been obtained thus far. In addition to the expected product which contains the cyano-isocyanide-ligand substituents, two additional products have been obtained: one containing two isocyanide groups and

one cyano group; and, a second product containing one cyano group and two ligand groups. A possible reaction pathway to explain the generation of these species has been suggested. In an effort to characterize the proposed reaction intermediate, a collaborative project has been initiated at Southampton with Professor Rest, an expert in the field of matrix isolation studies designed to isolate and identify "fast" reaction intermediates.

Mathematical Framework for Describing Immunoassay Systems

RESEARCHER: ASSISTANT PROFESSOR BOYD A. WAITE
SPONSOR: NAVAL RESEARCH LABORATORY

Previous studies of liposome-based immunoassays have resulted in a model for describing the mechanism of complement-mediated lysis involving monovalent antigen bound to the liposome surface and monovalent antibody specific to the antigen. The framework is extremely useful and easily extendable to the more realistic multivalent antibody problem.

The monovalent model has now been extended to include correctly the effects of multivalency of the binding antibody. The primary effect of this multivalency is in the cross-linking of antigen sites on the liposome surface. In the range of relevant experimental parameters, it was found that the original framework developed for the monovalent case was valid for this multivalent case, the only modification being in the form of the binding constant describing antigen antibody interaction. The modification indicates a linear dependence of the "binding constant" on lateral antigen density, in agreement with experimental observations. This functional af-

finity constant also includes a linear dependence on the valency of the attacking antibody, as expected. One of the major results of this analysis is a prediction of the minimum detectable concentrations of antibody in the range of 10^{-17} M, about a factor of 100, or more, higher in sensitivity than previous predictions.

In addition, a model has been developed for describing a sandwich assay in which the liposome is initially coated with Fab fragments. Antigen possessing two distinct determinants is then introduced. One of the determinants is specific to the surface bound Fab, while the other determinant is specific to a second antibody molecule introduced into the suspension, this second antibody eliciting the immunolysis phenomenon. While this is a less sensitive technique for determining antigen concentrations than the direct binding model previously described, it nevertheless serves to elucidate the mechanism of lysis for this sandwich-type assay.

Independent Research

Structure of Coke on a Zeolite Catalyst

RESEARCHER: CAPTAIN ROBERT M. ANDREWS, USMC

The cracking reaction of isopropylbenzene to form benzene and propylene was studied. Following the development of a new rate expression that involved concentration of reactants as opposed to time on stream, the coking of a lanthanum exchanged zeolite catalyst was measured in a packed tube reaction vessel. Measurements were made regarding the ex-

tent of catalyst coking along the length of the reactor as a function of different temperatures and catalyst weight. These measurements offered information regarding whether the coking is from reactants or products. The structure of the coke was examined using mass spectroscopy, x-ray, diffraction, and nuclear magnetic resonance spectrometry.

Protonation and Oxidation of Organometallic Compounds

RESEARCHER: ASSOCIATE PROFESSOR THOMAS E. BITTERWOLF

Metal atoms in many transition metal compounds are capable of acting as weak Lewis bases and may be protonated in acidic environments. For several years this laboratory has been concerned with the structure of protonated species and with reactions of protonated complexes. Detailed analysis of the geometry of a set of substituted ferrocene compounds has been published during the last year.

Detailed examination of the protonation and oxidation of a series of rhodium compounds resulted in the observation of a surprising set of previously unobserved reactions of these compounds. Reaction of cyclopentadienylrhodiumcarbonyl derivatives of either phosphines or phosphites with strong acids results in formation of a metal protonated species which is easily observed by NMR. Similar reactions of the phosphite derivatives in weaker acids yield

dinuclear rhodium dimers which were shown to arise from the reaction of protonated and nonprotonated species in solution.

Cyclopentadienylrhodiumcarbonyltriphenylphosphine has been shown by Connelly to form a ring coupled, dinuclear complex upon oxidation by either chemical or electrochemical techniques. Attempts to extend this reaction to other phosphine and phosphite derivatives resulted in the surprising observation that only the metal-metal coupled dimers could be isolated. Extensive studies have demonstrated that the metal-metal dimers form cleanly under electrochemical conditions, and work is now underway to understand the factors which control whether ring coupling or metal-metal coupling occurs.

Synthesis and Chemistry of Dinuclear Organometallic Complexes

RESEARCHER: ASSOCIATE PROFESSOR THOMAS E. BITTERWOLF

Dinuclear organometallic compounds in which two metal atoms are held in close proximity are ideal vehicles for the study of metal-metal interactions and for reactions in which two metal atoms are involved in a cooperative sense. The present project has been directed toward the synthesis of several families of compounds whose properties appear to be appropriate for studies of their chemical reactivity and electronic behavior. Significant progress has now been made in the synthesis of compounds of the type $\text{CH}_2(\text{CpM})_2$ where $\text{M} = \text{Mo}(\text{CO})_3$, $\text{W}(\text{CO})_4$, $\text{Mn}(\text{CO})_5$, $\text{Re}(\text{CO})_5$, $\text{Fe}(\text{CO})_4$, $\text{Ru}(\text{CO})_3$, $\text{Rh}(\text{CO})_2$, $\text{Ir}(\text{CO})_2$, and $(\text{C}_6\text{Me}_6)\text{TiCl}_2$. Each of these compounds has its own extensive chemistry which is beginning to be explored.

This year's work has been directed toward the synthesis of acetylene derivatives of Ru, Mo, and W compounds. These studies have resulted in the preparation of several new compounds containing both bridging acetylene and bridging vinylidene groups. The latter arise from rearrangement of terminal acetylenes. Crystal structures of several dinuclear compounds have been determined by Professor Arnold Rheingold of the University of Delaware.

Photochemical studies of $\text{CH}_2[\text{CpRu}(\text{CO})_2]_2$ have resulted in the discovery of a previously unobserved reaction in which photochemically generated metal radicals attack adjacent cyclopentadienyl rings to form a metacyclopentadienyl single bond.

Spin-Orbit Effects in Reactions of Metastable Alkaline Earth Metal Atoms With Simple Oxidants

RESEARCHER: LIEUTENANT MARK L. CAMPBELL, USNR

The dependence of the chemiluminescence cross section on initial spin-orbit level has been measured for the reaction of metastable $\text{Ca}(4s4p\ ^3\text{P}_2^0)$ with several alkyl halides and SF_6 , using an optical pumping state selection technique. Optical pumping depletion was also used to determine what fraction of the chemiluminescence was due to the second metastable $\text{Ca}(4s3d\ ^1\text{D})$ state present in the atomic beam. Chemiluminescence cross sections for both the $^1\text{P}^0$ and ^1D reactions were separately determined; total attenuation and intramultiplet mixing cross sections were also estimated. The spin-orbit dependence for the chemiluminescence channel for all the reactants, with the exception of SF_6 , was substantial and of similar magnitude, with an order of reactivity $J=2 > J=1 > J=0$. By contrast, no spin-orbit effect was observed for the reaction with SF_6 .

Optical pumping state selection was also employed to study reactions of the $J=0$ and 2 spin-orbit states of the $\text{Sr}(5s5p\ ^1\text{P}^0)$ manifold. The chemiluminescence cross sections for the reaction of $\text{Sr}(^1\text{P}_2^0)$ with Cl_2 , Br_2 , CH_2Br_2 , and CH_2I_2 are found

to be at least 5-10 times larger than those of the $J=0$ state. Laser fluorescence detection was employed to study the reaction pathway leading to ground-state SrBr products for the reactions with HBr and CH_2Br_2 . An opposite ordering of reactivity was found, with the $J=0$ state being 2-3 times more reactive than the $J=2$ state.

The dependence of the chemiluminescence channels on incident spin-orbit state has been determined for the reaction of metastable $\text{Ba}(6s5d\ ^1\text{D}_2)$ with Cl_2 , Br_2 , CCl_4 , N_2O , and NO_2 . The cross sections for the neighboring metastable ^1D state were related to those for the $^1\text{D}_2$ multiplet by optical pumping on an intercombination line. For the halogen-containing reagents, the spin-orbit dependence of the reactivity was substantial for the BaX B-X emission and was in the order $J=3 > J=2 > J=1$. The differences in reactivity were somewhat less for the C-X chemiluminescence channel in the Cl_2 and Br_2 reactions. A very small spin-orbit dependence was observed in the N_2O and NO_2 reactions.

Molten Salt Electrochemistry: Effect of Protonic Impurity on Reduction of Aromatic Ketones

RESEARCHER: ASSOCIATE PROFESSOR GRAHAM T. CHEEK

In preparing room temperature molten salts such as aluminum chloride: 1-methyl-3-butylimidazolum chloride, a major consideration is the presence of water in the organic salt. The action of water with aluminum chloride produces a protonic species which may play an important role in the electrochemistry of compounds studied in the melt. This study has focused on electrochemical behavior of fluorenone in the molten salt. A purification technique has been developed which permits removal of virtually all water from the imidazolium chloride,

so that an initial point of reference (i.e., absence of protons from melt) can be attained for electrochemical studies. It has been found that fluorenone is protonated in this molten salt upon addition of small amounts of water to the purified melt. Reduction of fluorenone in the basic (excess of imidazolium chloride) melt leads to the pinacol (one-electron) product, whereas reduction in the acidic melt with added protons gives the alcohol (two-electron) product.

Reduction of Perfluorinated Ketones in Nonaqueous Solvents

RESEARCHER: ASSOCIATE PROFESSOR GRAHAM T. CHEEK

This study is designed to assess the effect of fluorine-substitution on the electrochemistry of various model organic compounds. Initial work has been carried out on decafluorobenzophenone and has involved reduction of this compound in acetonitrile. The radical anion produced upon one-electron re-

duction is extremely unstable, in marked contrast to the radical anion of benzophenone (the parent material). Continuing work deals with establishing the structure of the decomposition product of the decafluorobenzophenone radical anion.

Reduction of Metal Ions at Microelectrodes

RESEARCHER: ASSOCIATE PROFESSOR GRAHAM T. CHEEK

The electrochemical reduction of several transition metal cations (lead, copper, zinc, cadmium) has been investigated at 10 μm (diameter) platinum electrodes in acetonitrile. Initial results show that the deposition stripping curves for copper are very

well-defined, while those for zinc are extremely broad and almost featureless. In solutions containing no added supporting electrolyte, migration effects have been observed, leading to enhanced reductions currents for the cations.

Study of Bacteria Involved in Fouling of Surfaces

RESEARCHER: PROFESSOR R. REECE COREY

Bacteria collected from Severn River water are cultured in filtered river water and grown with various nutrients added. Limiting conditions for establishing

the bacterial mat necessary for the initiation of fouling are sought. To date cultures have shown very limited stability.

Method to Preserve an Endangered Species

RESEACHER: PROFESSOR R. REECE COREY

Use of tissue culture on the pink lady slipper may provide a way of saving this wild orchid from extinction. Use of commercial techniques which work

for commercial orchids to date have not succeeded with this plant.

Tris-Imidazole Cobalt (III) Complexes

RESEACHER: INSTRUCTOR LINDA MONA

The title compounds are model systems for carbonic anhydrase, a vital enzyme. Two such systems, one with a dipicolinate ligand and the parent compound, have been synthesized and analyzed. The kinetics of

these systems in reduction by ferrous dipicolinate and by ferrocyanide have been studied with the former compound. Studies on the latter compound are underway.

Synthesis and Characterization of Organometallic Complexes Using Photochemical Techniques

RESEACHER: ASSISTANT PROFESSOR JOYCE E. SHADE

The chemistry of cationic (pentahaptocyclopentadienyl)(olefin)iron dicarbonyl complexes and their subsequent reaction with a variety of nucleophiles at the olefinic position to produce stable sigma-bonded alkyliron complexes have been studied extensively. Little work has been done, however, with the ruthenium analogues of this system. The purpose of this research was the synthesis and characterization of several ruthenium carbonyl-olefin-isocyanide (CNR) complexes. Following the synthesis of several starting materials, it was possible

to make a series of anionic, cationic, and neutral ruthenium complexes containing carbonyl (CO) groups, cyano (CN) groups, and isocyanide (CNR) groups. Photolytic decarbonylation of these complexes in the presence of ethylene gas at 5°C produced two complexes: $[(C_5H_5)_2Ru(CNCH_3)(ethylene)_2]PF_6$ and $(C_5H_5)_2Ru(CN)(ethylene)_2$. Both complexes have been separated from the reaction mixtures and spectral data have been obtained to confirm their identity.

Synthesis and Characterization of $(\eta^5-C_5H_5)Fe(R\text{-prophos})X$

RESEACHER: ASSISTANT PROFESSOR JOYCE E. SHADE

Recently, methods for the generation of several chiral bidentate phosphine ligands have been reported to provide the compounds in excellent yields and with high optical purity. The majority of the research using these ligands has been in the development of catalysts for asymmetric syntheses, particularly in the areas of hydrogenations, hydrosilylations, and alkylations. Little has been done to study the formation of new cyclopentadienyl-metal complexes containing these ligands as substituents. The purpose of this project has been to prepare cyclopenta-

dienyl iron complexes containing the bidentate phosphine ligand $R-(+)\text{-1,2-bis(diphenylphosphino)propane}$ or $R\text{-prophos}$. The cationic complex $[(\eta^5-C_5H_5)Fe(R\text{-prophos})NCCH_3]Br$ has been prepared and characterized, along with a series of neutral derivatives of the form $(\eta^5-C_5H_5)Fe(R\text{-prophos})X$. This optically pure, resolved starting material necessary for the synthesis of the $R\text{-prophos}$ ligand has been obtained, and work is underway to synthesize several grams of this material.

Photochemical Study of Cyano-Iso-cyanide-Phosphine Complexes of Iron

RESEARCHER: ASSISTANT PROFESSOR JOYCE E. SHADE

Photolysis of the monoisocyanide complex, $(C_6H_5)_3Fe(CO)(CN)(CNCH_3)$, in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product $[(C_6H_5)_3Fe(CN)(CNCH_3)(PPh_3)]$ with loss of one equivalent of carbon monoxide. Two additional products have been obtained however: $(n^5-C_5H_5)Fe(CNCH_3)_2(CN)$ and $(n^5-C_5H_5)Fe(CN)(PPh_3)_2$. Similar results were obtained with a variety of phosphine, phosphite, arsine, and antimony ligands. Several of the reaction products have been isolated from the fairly clean reaction mixtures, and a variety of spectral data have been obtained to verify their identity. Further

purification and characterization of these compounds are continuing. In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp, and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic starting materials are being investigated under a variety of reaction conditions in order to analyze the system for any trend which might develop as a function of complex charge.



Research Course Project

Synthesis of Palladium "A" Frame Complexes Using Electron-Withdrawing Ligands

RESEARCHER: MIDSHIPMAN 1 C J. TIMOTHY BAYS
ADVISER: ASSOCIATE PROFESSOR THOMAS E. BITTERWOLF

Diphosphine ligands of the general type $(R_2P)_2CH_2$ have been extensively examined as bridging units in the preparation of dinuclear complexes. Of particular interest are compounds in which two of these diphosphine bridges couple two metal atoms. These complexes are called "A" Frame complexes because of the overall geometry of many of the complexes. Most research on compounds of this type has centered on "R" groups, which are electron donating, and which result in high electron densities at the metal atoms. Recent work by Pro-

fessor Raghuveer has permitted the synthesis of analogous compounds which contain electron withdrawing groups. These new compounds appear to be ideal for stabilizing complexes of palladium and promoting new reactions not possible with the more electron-rich derivatives.

The new diphosphine ligands did form excellent "A" Frame complexes with palladium. These complexes have reactivities which are different from those of the electron-rich compounds.



Publications

BITTERWOLF, Thomas E., Associate Professor, "Metallocene Basicity. VIII. Protonation of Bridge Substituted Ferrocenophanes in Strong Acid Media," *Inorganica Chimica Acta*, 117 (1986), 55-64.

A series of bridge-substituted [3]-, [4]-, and [5]-ferrocenophanes has been prepared and characterized by ^1H -NMR and mass spectroscopy. In trifluoroboric acid (HBF_4OH) solution, these ferrocenophanes protonate at the iron to form long-lived species which can be studied by ^1H -NMR. Analysis of the complex ^1H -NMR spectra of the protonated species suggests that bridge substituents either slow or block the free oscillation of the rings and bridges. The iron hydrogen chemical shift values have been shown to depend only on the length of the bridge and seem to be insensitive to substituents on the bridge.

BITTERWOLF, Thomas E., Associate Professor, "Protonation and Dimerization Reactions of Cyclopentadienylrhodiumcarbonylphosphine and Phosphite Derivatives," *Inorganica Chimica Acta*, 122 (1986), 175-184.

Eight cyclopentadienylrhodiumcarbonylphosphine and phosphite complexes have been prepared and their IR, ^1H , and ^{31}P -NMR spectra recorded. A good correlation between carbonyl stretching frequencies and rhodium-phosphorous coupling constants has been observed. Reaction of these compounds with trifluoromethanesulfonic acid, $(\text{CF}_3\text{SO}_3\text{H})$, forms the expected cationic rhodium-hydride species which were examined using ^1H and ^{31}P -NMR spectroscopy. Similar reactions between trifluoroacetic acid, $(\text{CF}_3\text{CO}_2\text{H})$, and the phosphine compounds gave evidence of rapid proton exchange at the metal. Reaction between trifluoroacetic acid and pentadienylrhodiumcarbonylphosphite compounds yielded new sets of rhodium hydride resonances, which were shown to be due to the formation of dinuclear rhodium complexes and cyclopentadienylrhodiumphosphite complexes which arise under the reaction conditions. A scheme for the formation of the reaction products is presented which is consistent with all of the experimental data.

BITTERWOLF, Thomas E., Associate Professor, "Bis(cyclopentadienylthallium)methane: A Versatile Intermediate For the Synthesis of Dinuclear Cyclopentadienylmetal Carbonyl Complexes," *Journal of Organometallic Chemistry*, 312 (1986), 197-206.

Bis(cyclopentadienylthallium)methane has been prepared from dicyclopentadienyl methane and was shown to be a versatile starting material for the synthesis of a series of new dinuclear carbonylmetal complexes. Reactions of $\text{CH}_2(\text{Cp}-\text{Tl})_2$ with carbonylhalometal complexes yielded $\text{CH}_2[\text{CpMn}(\text{CO})_5]_2$, $\text{CH}_2[\text{CpFe}(\text{CO})\text{Br}]_2$, $\text{CH}_2[\text{CpRu}(\text{CO})_2\text{Cl}]_2$, $\text{CH}_2[\text{CpRu}(\text{CO})_2]_2$, $\text{CH}_2[\text{CpRh}(\text{CO})_2]_2$, $\text{CH}_2[\text{CpRh}(\text{CO})_2-\mu-\text{CO}]_2$, and $\text{CH}_2[\text{CpIr}(\text{CO})_2]_2$. Reduction of the iron and ruthenium halide derivatives was found to give the metal-metal bonded complexes, or the corresponding dianions, depending on the time of the reaction and the stoichiometry. The reaction of these dianions with methyl iodide to give the methyl derivatives is described. The facile decarbonylation of $\text{CH}_2[\text{CpRh}(\text{CO})_2]_2$ and carbonylation of $\text{CH}_2[\text{CpRh}(\text{CO})_2-\mu-\text{CO}]_2$ appears to be a consequence of the proximity of the two metal atoms. In contrast, $\text{CH}_2[\text{CpIr}(\text{CO})_2]_2$ does not appear to form an analogous bridging compound under the reaction conditions. Complete spectral and physical data for the compounds are presented.

BITTERWOLF, Thomas E., Associate Professor, Robert HERZOG, and Paul D. ROCKSWOLD, Ensigns, U.S.N., "Synthesis and Conformations of Chromium Tricarbonyl substituted Diarenes," *Journal of Organometallic Chemistry*, 320 (1987), 197-209.

The metallation of a series of seven planar and bent diarenes has been examined to determine the conformations of the mono- and dimetallated products. It has been found that bent diarenes can be metallated on either the convex (*syn*) or concave (*anti*) faces of the arene. In the absence of other directing groups, metallation at the concave face is favored. Dimetallation of planar diarenes results in the exclusion of *trans*-metallation. Dimetallation of bent diarenes yields the *trans* isomer as the major species, but *cis*-dimetallation of the convex face is also observed. Conformation assignments have been made using ^1H and ^{13}C -NMR spectral evidence.

BITTERWOLF, Thomas E., Associate Professor, "Reaction of Sulfur Dioxide with New Dinuclear Rhodium Compounds," *Journal of Organometallic Chemistry*, 320 (1987), 121-127.

The reaction of sulfur dioxide with two new dinuclear rhodium compounds has been examined. The dinuclear compounds are unique in that two cyclopentadienylrhodium moieties are coupled by a methylene linkage between the rings. This linkage appears to result in geometric and kinetic factors which favor reactions in which Rh-Rh bond formation may occur. Reaction of $\text{CH}_2[\text{CpRh}(\text{CO})]_2-\mu-\text{CO}$ with SO_2 results in the formation of a $\mu-\text{SO}_2$ derivative, $\text{CH}_2[\text{CpRh}(\text{CO})]_2-\mu-\text{SO}_2$, and a second compound which may be an SO_2 adduct of $\text{CH}_2[\text{CpRh}(\text{CO})]_2-\mu-\text{CO}$. Reaction of SO_2 with $\text{CH}_2[\text{CpRh}(\text{ene})]_2$ gives a $\mu-\text{S}_2\text{O}_4$ derivative which is the first example of a bridging dithionite compound in the rhodium series.

CAMPBELL, Mark L., Lieutenant, USNR, co-author, "The Reaction of Spin-orbit State-selected $\text{Ca}(^3\text{P}_j^0)$ with CH_3I , CH_2I_2 , and SF_6 ," *Laser Chemistry*, 6 (1986), 391-402.

Chemiluminescence cross sections for reaction of the individual spin-orbit states of metastable $\text{Ca}(^3\text{P}_j^0)$ with CH_3I , CH_2I_2 , and SF_6 have been determined by the use of optical pumping state selection. This technique was also used to separate the chemiluminescence yield arising from the two excited metastable $\text{Ca}(^3\text{P}^0)$ and ^1D sites. The spin-orbit dependence of the pathway of chemiluminescence pathway was found to be substantial for the CH_3I and CH_2I_2 reactions and similar to that previously observed for halogen diatom and alkyl bromide reagents. By contrast, no spin-orbit effect was observed for $\text{Ca}(^3\text{P}^0)+\text{SF}_6$. These results are discussed in terms of our previously presented model for the origin of spin-orbit effects in chemical reactions.

CAMPBELL, Mark L., Lieutenant, USNR, co-author, "Effect of Spin-orbit State on Chemical Reactivity: Study of Chemiluminescent and Ground-state Products from Reaction of $\text{Sr}(^3\text{P}_j^0)$ with Several Halogen-containing Molecules," *Journal of the American Chemical Society*, 108 (1986), 4701-4706.

Optical pumping state selection has been employed to study reactions of the $J=0$ and 2 spin-orbit states

of the $\text{Sr}(5s5p^3\text{P}^0)$ manifold. The chemiluminescence yield cross sections for reaction of $\text{Sr}(^3\text{P}^0)$ with Cl_2 , Br_2 , CH_2Br_2 , and CH_2I_2 are found to be at least 5-10 times larger than those of the $^1\text{P}^0$ state. Laser fluorescence detection was employed to study the spin-orbit dependence of the reaction pathway leading to ground-state SrBr products for $\text{Sr}(^3\text{P}_0^0)/\text{HBr}$ and CH_2Br_2 . An opposite ordering of reactivity was found for this pathway, with $^3\text{P}_0^0$ being 2-3 times more reactive than $^3\text{P}_2^0$. These results, which are qualitatively and nearly quantitatively similar to our previous observations on $\text{Ca}(^3\text{P}^0)$ reactions, are discussed in terms of a dynamical model for understanding spin-orbit effects in chemical reactions.

CAMPBELL, Mark L., Lieutenant, USNR, co-author, "The Effect of Incident Spin-orbit State on the Chemiluminescent Reactions of $\text{Ba}(^3\text{D}_j)$ with Several Oxidants," *Journal of Chemical Physics*, 85 (1986), 4453-4462.

The dependence of the chemiluminescence yield channels on incident spin-orbit state has been determined by utilizing optical pumping state selection for the reactions of metastable $\text{Ba}(6s5d^3\text{D}_j)$ with Cl_2 , Br_2 , CCl_4 , N_2O , and NO_2 . The cross sections for the neighboring metastable ^1D level were related to those for the $^3\text{D}_j$ multiplet by optical pumping on an intercombination line. For the halogen-containing reagents, the spin-orbit dependence of the reactivity was substantial for BaX B-X emission and was in the order $J=3 > J=2 > J=1$. The differences in reactivity were somewhat less for the C-X chemiluminescence yield channel in the Cl_2 and Br_2 reactions. Essentially no spin-orbit dependence was observed in the N_2O and NO_2 reactions.

CAMPBELL, Mark L., Lieutenant, USNR, co-author, "Spin-orbit Effects in Gas-Phase Chemical Reactions," *Chemical Reviews*, 87 (1987), 1-18.

Review of the concept of spin-orbit states, the method for selecting such states, and methods for their detection is followed by the examination of gas-phase reactions of a number of species. These include halogen atoms, metastable excited inert gases, inert gaseous ions, metastable alkaline earth metal atoms, metastable mercury, as well as cadmium atoms, germanium atoms, tin atoms, and lead atoms, followed by some miscellaneous observations of other metal atoms.

CHEEK, Graham T., Associate Professor, co-author, "Rapid Evaluation of Lithium Battery Catalysts by Voltammetric Methods," *Proceedings of the Symposium on Lithium Batteries*, A. N. Dey, ed., *Electrochemical Society Proceedings*, 87-1 (1987), 84.

In conducting research on lithium/liquid cathode battery systems, it has become evident that a method for rapidly evaluating potential catalysts is very desirable. The work described in this paper deals with the catalytic reduction of selected halocarbons by cobalt tetraazaannulene, studied both by voltammetric methods and by actual cell discharges. It has been found that the voltammetric measurements of catalyst activity correlate rather well with discharge potentials of lithium cells employing these halocarbon/catalyst combinations.

DUDIS, Douglas S., Assistant Professor, co-author, "Synthesis, Characterization, and Crystal Structures of Two Scandium Cluster Carbides and A Boride, $\text{Sc}_7\text{X}_{12}\text{C}$ ($\text{X}=\text{I}, \text{Br}$) and $\text{Sc}_7\text{I}_{12}\text{B}_3$," *Inorganic Chemistry*, 25 (1986), 3434-3438.

The isomorphous compounds $\text{Sc}(\text{Sc}_6\text{I}_{12}\text{C})$ and $\text{Sc}(\text{Sc}_6\text{Br}_{12}\text{C})$ were prepared and their structures determined by x-ray diffraction. They exhibit significantly asymmetric halogen environments about the isolated scandium atoms and a distortion of the cluster from D_{3d} to C_3 symmetry. The magnetic susceptibility of the iodide is in agreement with the calculated molecular orbital description and the assignment of the isolated atom as $\text{Sc}(\text{III})$. The analogous iodide boride was synthesized and characterized by X-ray powder data.

DUDIS, Douglas S., Assistant Professor, co-author, "The Synthesis, Structure, and Some Properties of the Infinite Chain Compounds $\text{Sc}_3\text{Cl}_8\text{C}$ and $\text{Sc}_3\text{Cl}_8\text{N}$," *Inorganic Chemistry*, 26, (1987), 469-473.

The phases $\text{Sc}_3\text{Cl}_8\text{Z}$, $\text{Z}=\text{C}$ or N , are obtained from reactions of Sc , ScCl_3 , and graphite or NaN_3 at 900-950 °C in sealed niobium tubing. The structures of both have been determined by single crystal diffractions. The cell dimensions of and distances within the carbide are indistinguishable from those reported earlier from a less satisfactory refinement of the structure of " Sc_3Cl_8 ." The structures contain infinite pairs of chains composed of $\text{Sc}_3\text{Cl}_{12}$ Z-type

clusters sharing both opposite metal edges and chlorine atoms and of ScCl_6 clusters likewise condensed ($\sim \text{ScCl}_{12}$). Magnetic susceptibility measurements, Al (K- α) and He (I) photoelectron spectra, and extended-Huckel band calculations are also reported. Both compounds are predicted to be metallic.

DUDIS, Douglas S., Assistant Professor, co-author, "Metal-Metal Bonding and Interstitials in Reduced Rare Earth Metal Halides," *Journal of Less-Common Metals*, 127 (1987), 1-6.

Exploratory research in recent years has shown that the rare earth elements in their highly-reduced halides exhibit a remarkable ability to undergo cluster formation, some as isolated units, and others as infinite chains or slabs containing double metal layers. Only a few of the elements have been studied in any detail, principally scandium, yttrium, and gadolinium. Many of these new compounds are uniquely stabilized by a second-period element bound within each cluster, although a few structures evidently present true binary phases. The known phases and their structures are briefly reviewed, and some relevant information from extended-Huckel band calculations and UV photoelectron spectroscopy are noted.

ELERT, Mark L., Associate Professor, and Edward KOUBEK, Professor, "Calculation of Madelung Constants in the First Year Chemistry Course," *Journal of Chemical Education*, 63 (1986), 840-841.

The Madelung constant is a measure of the strength of bonding in an ionic crystal. Its calculation for a particular crystal lattice involves summation of all interionic electrical interactions over an infinite three-dimensional crystal. Elegant methods for approximating this summation have existed since the 1930s, but their description is beyond the scope of a typical freshman chemistry course. In this paper, simple approximations for computing ionic bonding strengths in finite one-dimensional and three-dimensional crystal fragments are presented, along with a computational scheme for rather accurate Madelung constant calculations which can be easily implemented by students using a microcomputer. Traditional methods for the evaluation of Madelung constants are also reviewed.

ELERT, Mark L., Associate Professor, co-author, "Heteroatom Effects in Heterocyclic Ring Chain Polymers," *Synthetic Metals*, 16 (1986), 235-243.

Recent experimental results for the heterocyclic ring chain polymers, such as polythiophene and polypyrrole, have been most frequently interpreted in terms of their carbon backbone structure. Previous theoretical studies have assumed that the heteroatom in these systems has negligible effect on the pi-band structure of the chain, except for its effects on the sigma-bond structure. Using concepts similar to those of the Su-Schrieffer-Heeger model, it was demonstrated that the converse is true. The dominant effect of the heteroatom on the pi-band structure is via the direct interaction of the heteroatom p-orbital lone pair with the carbon backbone pi-band structure.

LINCK, Robert G., Associate Professor, "Classification of Electron-Transfer Reactions," *Inorganic Reactions and Methods*, Vol. 15, ed. J. J. Zuckerman, Deerfield Beach, Florida, VCH Publishers, Inc., pp. 3-16.

The concept of classifying electron-transfer reactions to either inner-sphere or outer-sphere mechanism is reviewed and discussed. Examples of the three general types of inner-sphere reactions are given. Typical outer-sphere transition states are also presented.

LINCK, Robert G., Associate Professor, "Specific Reactivity Patterns in Electron-Transfer Reactions," *Inorganic Reactions and Methods*, Vol. 15, ed. J. J. Zuckerman, Deerfield Beach, Florida: VCH Publishers, Inc., pp. 68-87.

This chapter is a review of the rates of oxidation-reduction reactions. These rates are described by three parameters, two of which are determined solely by the nature of the two reagents, respectively, and a third which depends on the two reagents considered as a pair. A test of this model shows reasonable success in correlating observed data. Cor-

rections to the model for changes from outer-sphere to inner-sphere reactivity are given. Multiple electron oxidants, reactions of coordinated ligands and catalysis of electron-transfer reactions are also discussed.

ROWELL, Charles F., Professor, "Flashpoint!" *Chem-Matters* (December 1986), 12-14.

In the summer of 1985, a fuel oil tank in Baltimore exploded and burned, killing one and severely injuring two. Official investigations could not explain the explosion until the fundamental definition of *flashpoint* was utilized to provide the right line of inquiry. (This story was used to explore the nature of vapor pressure versus temperature for the high school audience of this publication.)

SHADE, Joyce E., Assistant Professor, co-author, "Chiral Iron Complexes (η^5 -C₅H₄CH(Ph)CH₃)Fe(CO)(L)X (L = Phosphine, Phosphite; X = Acyl, Alkyl, Halide, Hydride)," *Journal of Organometallic Chemistry*, 319 (1987), 391-406.

The complex [η^5 -C₅H₄CH(Ph)Me)Fe(CO)₂]₂ was synthesized by the reaction of Fe₂(CO)₉ with alpha-phenylethylcyclopentadiene in benzene at room temperature while stirring under nitrogen. This dinuclear compound was converted to Cp*Fe(CO)₂CH₃ (where Cp* = η^5 -C₅H₄-CH(CH₃)C₆H₅) by reduction with sodium amalgam and addition of CH₃I. Reaction of this dicarbonyl methyl complex in the presence of triphenylphosphine under reflux conditions gave the acetyl complex, Cp*Fe(COCH₃)(CO)(PPh₃). Separation of the two diastereomerically related pairs of enantiomers of the acetyl compound was accomplished by combination of column chromatography on alumina and crystallization from chloroform/pentane. The photochemical decarbonylation of the acetyl diastereomers was examined by ¹H NMR spectroscopy. This reaction proceeds with high stereospecificity at the iron center to yield Cp*Fe(CH₃)(PPh₃). The mechanism of this decarbonylation process is discussed.

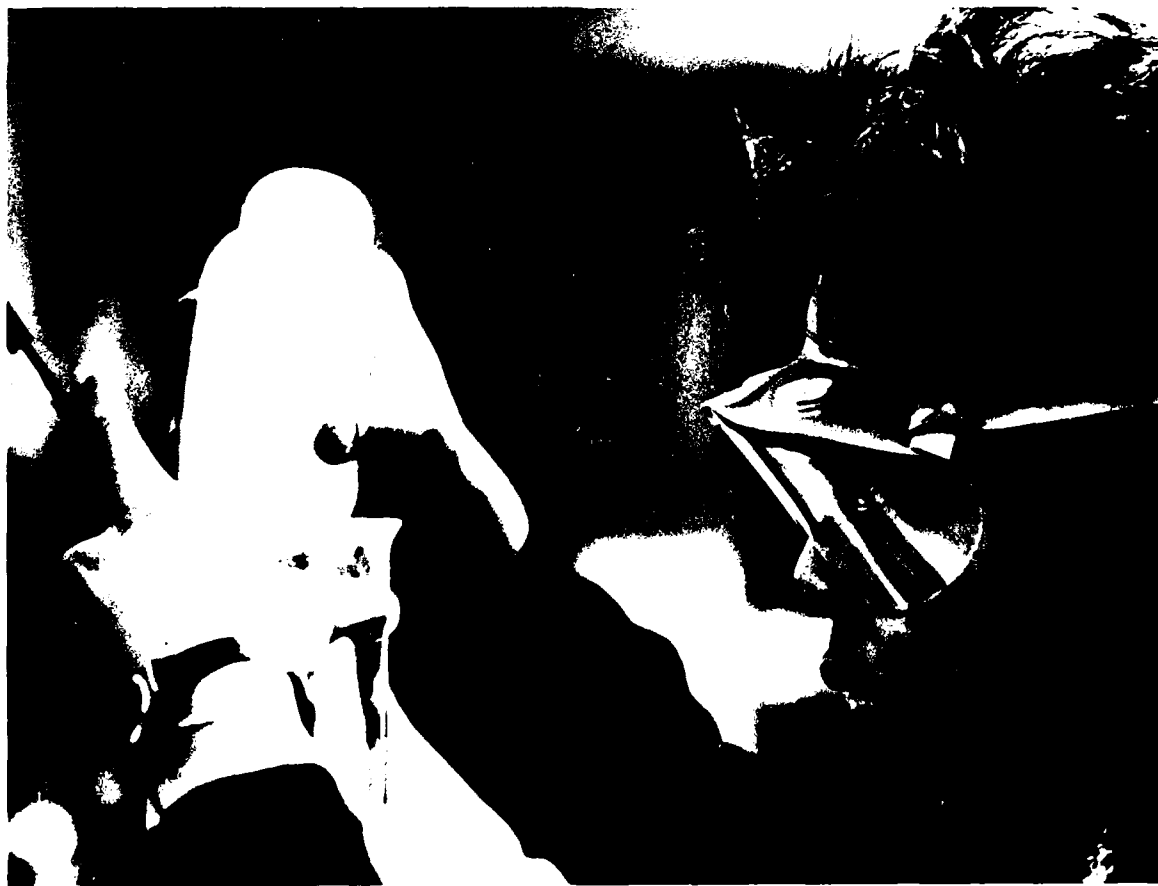
WAITE, Boyd A., Assistant Professor, "A Simple Molecular Interpretation of Entropy," *Chemical Engineering Education*, 21 (Spring 1987), 98-100.

A simple explanation of the connection between molecularity (as contained in gas kinetic theory of distributions) and the macroscopic quantity entropy is presented. Entropy, defined as a measure of the randomness relative to some reference condition, is interpreted in terms of flow of randomness from one system to another. Entropy changes for simple gas phase compression processes are explained in relation to the interactions between different types of distributions of particles.

WAITE, Boyd A., Assistant Professor, co-author, "The Role of Cluster Ion Structure in Reactivity and Collision-induced Dissociation: Application to Cobalt/Oxygen Cluster Ions in the Gas Phase," *Journal of Chemical Physics*, 86 (February 1987), 1276-1288.

Ion/molecule reaction products of cobalt cluster ions have been characterized using mass spectrometric

techniques. Sputtered metal cluster ions react with O_2 to produce abundant stoichiometric or nearly stoichiometric cobalt(II) oxygen cluster ions. Tandem mass spectrometry and collision spectroscopy provide structural information about the more abundant cobalt cluster product ions. Geometric structures of the cobalt/oxygen cluster ions were calculated using a coulomb plus Born/Mayer pair-potential model. The oxygen-equivalent cluster structures were found to be "globular" cages, rings, or ladders. The oxygen-deficient cluster structures were found to be strained and "angular" with protruding cobalt atoms. The structures are discussed in terms of the observed collision-induced fragmentations. The fragmentations are rationalized using an "instantaneous" dissociation model of the collision-induced dissociation of the cluster ions. Preliminary trajectory calculations using classical dynamics support the use of this instantaneous dissociation model. The role of cluster ion structure in reactivity and collision-induced dissociation is discussed in terms of the experimental data and theoretical structures.



Presentations

BITTERWOLF, Thomas E., Associate Professor, **"Recent Developments in Binuclear Organotransition Metal Chemistry,"** Department of Chemistry, The University, Bristol, England, 20 June 1986.

BITTERWOLF, Thomas E., Associate Professor, **"Recent Progress in Coupled Dinuclear Complexes,"** Department of Chemistry, University of Padova, Padova, Italy, 2 July 1986.

BITTERWOLF, Thomas E., Associate Professor, **"Recent Progress in the Chemistry of Dinuclear Transition Metal Complexes,"** Department of Chemistry, University of Rome "La Sapienza," Rome, Italy, 30 June 1986.

BITTERWOLF, Thomas E., Associate Professor, **"Protonation and Acid Catalyzed Dimerization of Cyclopentadienylrhodiumcarbonyl Phosphine and Phosphite Complexes,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

BITTERWOLF, Thomas E., Associate Professor, **"Solution and Matrix Isolation Studies of the Photolysis of the Dimers of $[\text{CpRu}(\text{CO})_2]_2$ and $\text{CH}_2[\text{CpRu}(\text{CO})_2]_2$,"** Annual Congress of the Royal Society of Chemistry, Swansea, Wales, 14 April 1987.

BITTERWOLF, Thomas E., Associate Professor, **"Synthesis and Chemistry of Dinuclear Cyclopentadienyl Metal Complexes,"** Department of Chemistry, University of Delaware, Newark, Delaware, 29 April 1987.

CHEEK, Graham T., Associate Professor, **"Electrochemical Reduction of Pentafluorobenzoyl Chloride,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

CHEEK, Graham T., Associate Professor, **"Rapid Evaluation of Lithium Battery Catalysts by Voltammetric Methods,"** Electrochemical Society Fall Meeting, San Diego, California, 22 October 1986.

CHEEK, Graham T., Associate Professor, **"Stripping Voltammetry of Metal Ions in Nonaqueous Solvents at Ultramicroelectrodes,"** Gordon Conference on Electrochemistry, Santa Barbara, California, 20 January 1987.

CHEEK, Graham T., Associate Professor, **"Electrochemical Reduction of Aromatic Ketones in a Room-Temperature Molten Salt,"** Electrochemical Society Spring Meeting, Philadelphia, Pennsylvania, 13 May 1987.

DAVIS, Edward R., Assistant Professor, **"Spin Trapping in Ordered Media,"** Chief of Naval Research Program Review, Annapolis, Maryland, 9 September 1986.

DUDIS, Douglas S., Assistant Professor, **"Synthesis, Structure and Bonding of Three Interstitially Stabilized Cluster Compounds,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

DUDIS, Douglas S., Assistant Professor, **"Zirconium Triiodide Revisited – A Classic Peierls Distortion,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

DUDIS, Douglas S., Assistant Professor, **"Solid State Inorganic Chemistry – or – Shake and Bake/Heat and Beat Chemistry,"** University of Maryland, College Park, Maryland, 24 March 1987.

KOUBEK, Edward, Professor, **"Quantitative Lecture Demonstrations,"** Ninth Biennial Conference on Chemical Education, University of Montana, Missoula, Montana, 15 July 1986.

KOUBEK, Edward, Professor, **"Why and How to Organize an Interdisciplinary Energy Course,"** Ninth Biennial Conference on Chemical Education, University of Montana, Missoula, Montana, 14 July 1986.

MASSIE, Samuel P., Professor, **"Some Aspects of Pre-Health Science Preparation at the U.S. Naval Academy,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

SHADE, Joyce E., Assistant Professor, **"Photochemical Investigation on Isocyanide Iron Complexes in the Presence of Phosphine/Phosphite Ligands,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 4 September 1986.

SHADE, Joyce E., Assistant Professor, **"Solution and Matrix Isolation Studies of the Photolysis of the Dimers of $[\text{CpRu}(\text{CO})_2]_2$ and $\text{CH}_2[\text{CpRu}(\text{CO})_2]_2$,"** Annual Conference of the Royal Society of Chemistry, Swansea, Wales, 13 April 1987.

WAITE, Boyd A., Assistant Professor, **"The Role of Cluster Structure in Collision-Induced Dissociation: Transition-Metal Oxygen Cluster Ions,"** Twentieth Middle Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 3 September 1986.

WAITE, Boyd A., Assistant Professor, **"Modeling of Vesicle Immunolysis Assays,"** Twentieth Middle

Atlantic Regional Meeting of the American Chemical Society, Baltimore, Maryland, 3 September 1986.

WAITE, Boyd, A., Assistant Professor, **"Mathematical Modeling of Vesicle Immunolysis Assays: The Direct Binding Model, the Multivalent Cross-linking Model, and the Sandwich Model,"** Workshop on Theoretical Immunology, Santa Fe, New Mexico, 10-12 June 1987.

WALTON, Edward D., Assistant Professor, **"Things Electric: Hands-on Science Activities,"** Maryland Association of Science Teachers Fall Conference, Ocean City, Maryland, 22 October 1986.

WALTON, Edward D., Assistant Professor, **"Science Education: Where Do We Go From Here?,"** Baltimore's Third Annual Science Fair, Baltimore, Maryland, 25 April 1987.

WALTON, Edward D., Assistant Professor, **"The Nature of the Phosphoryl Bond: The Octet Rule or Not!,"** Chemistry Seminar Series, Department of Chemistry, California State University, Northridge, California, 30 April 1987.

WALTON, Edward D., Assistant Professor, **"Making It Work: Science Education in Elementary Schools,"** Maryland Association of Science Teachers Conference for Elementary School Science Teachers, U.S. Naval Academy, Annapolis, Maryland, 9 May 1987.



Computer Science

ASSOCIATE PROFESSOR FREDERICK A. SKOVE
CHAIRMAN

This past year, research activity increased significantly in the Computer Science Department. It is believed that this research promotes the reputation of the Department and the Academy, contributes to the computer science field, and makes available new concepts for computer classes. The primary areas of research include, but are not limited to: Artificial Intelligence, Software Engineering, Networks, and Databases.

Research endeavors within the Computer Science Department are coordinated by the Department Research Committee. This committee is composed of both military and civilian faculty members. Faculty research was funded by the Naval Academy Research Council and Naval Research Laboratory (NRL). In addition, three military faculty have begun to develop the AT&T grant equipment for use in a large scale integrated war gaming tactics course, establish teaching laboratories in ADA, UNIX, and distributed processing and software engineering. The Computer Science Department encourages its entire faculty to engage in research, because it is believed that both faculty and students benefit. Research will continue to hold a high priority within this department.



Sponsored Research

A Computer Model of Flow in an Oil-Free Compressor

RESEARCHER: ASSOCIATE PROFESSOR FRANK L. K. CHI

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

A computer model of the flow in a groove of an oil-free, single screw compressor is developed. The groove is approximated by a channel of irregular cross sections, and the flow in the groove is assumed

to be laminar. The working fluid is non-ideal. The advancing of the rotor is simulated by a piston moving from the left end to the right. The model is used to predict the pressure wave in the groove.

Tactical Artificial Intelligence Demonstrator

RESEARCHERS: PROFESSOR PATRICK R. HARRISON AND ASSOCIATE PROFESSOR
CHARLES G. BROCKUS (WEAPONS AND SYSTEMS ENGINEERING)

SPONSOR: NAVAL RESEARCH LABORATORY

TACAID is a Knowledge-Based system designed to improve the figure of merit of data from passive sono-buoys by providing:

- (1) increased precision in the analysis of the horizontal undersea environment.
- (2) increased parallelism in the analysis of buoy data channels, and
- (3) development of a detailed and consistent quantized problem history.

The system is being prototyped on a Texas Instrument Lisp machine using the KEE development environment. The system will be capable of non-monotonic reasoning and reasoning from first principles as well as using compiled knowledge. The system will test important generic concepts for the development of Command and Control applications.



A Reliable Database for Distributed Graphics Systems

RESEARCHER: ASSISTANT PROFESSOR FRANK M. PITTELLI

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

As computer networks become increasingly available to PC users, the efficient use of distributed graphics will become an important topic. Currently, graphics systems are primarily used in a "local" mode. That is, the display and manipulation of objects are performed locally on a given machine. If such pictures or objects need to be transferred to another machine (e.g., the printer), they must be encoded in some form, transmitted to the other host, and re-drawn. Unfortunately, this limits the types of pictures which can be transferred or displayed. Furthermore, as graphics systems become larger, it is desirable to have multiple users share the same storage structure. In this way, storage costs are reduced and related tasks are more easily coordinated. Finally, as pictures become an important part of the work environment, they must be maintained in a reliable manner: despite computer and disk failures, the picture representations should remain intact.

The research for this project will proceed in three steps. First, the overall system will be designed, paying particular attention to the major functional re-

quirements and the desired performance. The objective is to develop significant improvements in the manner in which graphical objects are stored in an otherwise conventional database system. Furthermore, the researcher hopes to improve the methods currently used for the transfer of such objects over a computer network.

Next, two experimental software systems will be implemented on a network of three PCs within the Computer Science Department. One, a reliable database system, supports high performance transaction processing, while the other supports graphics processing on many different displays, over a computer network. After implementing the experimental software systems on the PC network, they will be modified to reflect the chosen design.

The results of this research will contribute to two rapidly converging research areas: distributed graphics systems and high-performance database systems. Both of these areas are becoming increasingly important topics with regard to the computer networks currently being used and those which are being designed.

Autonomous Land Vehicle

RESEARCHER: MIDSHIPMAN 1/C JOHN P. MELLOR

ADVISERS: PROFESSOR PATRICK R. HARRISON AND PROFESSOR RALPH P. SANTORO

(ELECTRICAL ENGINEERING DEPARTMENT)

SPONSOR: TRIDENT SCHOLAR PROGRAM

The objective of this research was to develop a knowledge-based, artificially intelligent system for the control of an autonomous land vehicle. The project required the construction of a simulation consisting of a model of the world and a model of the vehicle. The simulation was constructed on a Lisp machine using the hybrid programming environment provided by KEE. This approach facilitated

the modeling of a dynamic world, multiple vehicles, reasoning about time, and incremental development of the vehicle and world. The simulation used objects and rules and is capable of both forward- and backward-chained reasoning. The finished control system can operate in a single or multi-vehicle world. It is capable of avoiding obstacles and can remember its own behavior.

Independent Research

Local Area Network

RESEARCHER: ASSISTANT PROFESSOR CLAYTON A. DANE

This project continues work from last year which was sponsored by the Naval Academy Research Council on CS-232 local area network. The re-

searcher has prepared and submitted a paper on his work to Chips-Ahoy (NAR-DAC).

Multiple Fault Diagnosis Using ATMS

RESEARCHER: PROFESSOR PATRICK R. HARRISON

The purpose of this research is to develop a Multiple Fault Diagnosis system capable of dealing with analog or digital systems. The model uses constraint propagation as the basic inferencing mechanism and assumption-based truth maintenance to eliminate the need for backtracking and to provide control for non-monotonic reasoning justifications. Operational avionics boards are being used for this project.

The problem of which component to test next will be developed using minimal entropy theory initially with several alternatives, including an application of covering theory tested later. In addition, fault trees or compiled knowledge about a particular board will be used to constrain further the search space.

Experimental Analysis of a TMR Database System

RESEARCHER: ASSISTANT PROFESSOR FRANK M. PITTELLI

This project was the culmination of graduate research leading to a Ph.D. in Computer Science from Princeton University. The goal was to show that Triple Modular Redundant techniques could be applied to database processing, thereby providing for high reliability and availability without loss of processing efficiency. The thesis presented novel methods for transaction scheduling, processor coordination, and recovery in such an environment. For all of these methods, actual implementation results were derived and presented, showing a clean transition from a "paper design" to a running application. In general, the researcher formalized the inherent cost, both in resources and performance associated with such an approach. By comparing the redundancy method with other conventional database techniques, it was shown that there were real applications which could prosper from the former.

Although this particular project has ended, the information and methods derived from it are being carried into other cases. In particular, the algorithms used for triple modular redundancy can be streamlined to work with dual processor systems. In such a case, the resulting drop in reliability is offset by a predictable increase in performance. Furthermore, such a system is capable of higher performance than a conventional system with equal reliability and availability.

The redundancy methods studied in this project are also being applied to specialized database systems. Specifically, a current project involves the use of these techniques to support a large, distributed graphics database. The advantage of this approach over conventional systems is the simplicity of dual redundant systems and their higher performance when processing unusual transactions.

High Performance Network Simulation

RESEARCHER: ASSISTANT PROFESSOR FRANK M. PITTELLI

The world of supercomputers and parallel processors has created a need for very powerful research tools. One of the most essential tools is that of a network simulator. Before hardware engineers can design or build new architectures, they must have an accurate approximation of its performance characteristics. Previous simulators built in university environments have suffered from poor performance themselves. This forces researchers to use a less detailed model of the target architecture in order to run their experiments in reasonable amounts of time.

The goal of this project is to implement a flexi-

ble, high-performance network simulator for research purposes. The simulator will be designed specifically with vector processing techniques in mind and will be implemented on a number of current supercomputers, including the CRAY-2, Convex C-1, and MultiFlow systems. Coupled with the design of the simulator is the design of an experimental parallel processor also being developed at the Supercomputing Research Center. By designing the network simulator with a real application in mind, the researcher hopes to have a solid basis for performance measurements and enhancements.

U.S. Naval Academy AT&T Grant

RESEARCHERS: LIEUTENANT COMMANDERS DAVID J. SMANIA, USN, MARK J. GESCHKE, USN, AND WILLIAM G. BORRIES, USN

The objective of this project is developing the AT&T grant equipment to assume the NAVTAG Professional Development War Gaming Tactics Course. The project includes: connecting and transferring 500,000 lines of Fortran code from the Wycat com-

puter system to the new AT&T equipment, establishing research and teaching laboratories in ADA and UNIX operating and programming languages, and networking the NAVTAG and ADA research systems individually and together.



Research Course Project

Object Oriented Simulation of Processor Architectures Using SCHEME

RESEARCHER: MIDSHIPMAN J. C. JOSEPH MORALES

ADVISER: PROFESSOR PATRICK R. HARRISON

The goal of this project was to use object-oriented LISP programming to simulate the structures, functions, and connectivity of the major components of a 8086 style processor. Each module maintained its own event queue, and a variety of performance data was maintained for each component. This part of the project was completed using SCHEME, a lexically scoped LISP and SCOOPS, an object-oriented

programming package implemented in SCHEME. In addition, an attempt was made to implement the complete instruction set of the processor and then track performance across architectural modifications. This included keeping track of the contents of various registers as well as timing and queue statistics. This part of the project has been partially completed.



Publications

PITTELLI, Frank M., Assistant Professor, "Database Processing with Triple Modular Redundancy," NSA *Cryptologic Quarterly* (March 1987), 23-44.

N-Modular Redundancy (NMR) protects against arbitrary types of hardware or software failures in a minority of system components, thereby yielding the highest degree of reliability. In this paper, the author studies the application of NMR, specifically Triple Modular Redundancy (TMR), to general-purpose database processing. He discusses the structure and implementation tradeoffs of a TMR system that is "synchronized" at the transaction level. Complete transactions are distributed to all nodes, where they are processed independently, and only the majority output is accepted. The author examines the inherent "cost" of such a TMR database system by presenting preliminary performance results from a version implemented on three SUN-2/120 workstations.

PITTELLI, Frank M., Assistant Professor, co-author, "Recovery in a Triple Modular Redundant Database System," USNA Report CS-87-002, January 1987.

In a Triple Modular Redundant (TMR) database system, the database is fully replicated at three computers. All transactions are executed at all nodes in the same relative order. The system can tolerate the arbitrary failure of a single computer, since the cor-

rect data can be obtained from the two operating copies. After a failure, it is important to repair the computer so that the system can tolerate additional future failures. Repair in this case involves getting a correct and up-to-date copy of the database, without halting the two operational nodes. In this paper the authors analyze this database recovery problem. They describe a solution that has been implemented on an experimental TMR system running on SUN-2/120 workstations. They also present performance results that illustrate the cost of recovery.

PITTELLI, Frank M., Assistant Professor, co-author, "Efficient Scheduling in a TMR Database System," USNA Report CS-87-001, January 1987.

A Triple Modular Redundant (TMR) system achieves high reliability by replicating data and all processing at three independent nodes. When TMR is used for database processing all non-faculty computers must execute the same sequence of transactions, and this is ensured by a collection of processes known as "schedulers." In this paper the authors analyze the performance of these schedulers using an experimental TMR system which is designed to handle a single arbitrary node failure. The results show that a scheduling algorithm exists which exhibits acceptable performance, both in terms of response time and throughput, despite its reliance on a Byzantine Agreement algorithm to maintain consistency.

Presentations

PITTELLI, Frank M., Assistant Professor, "Synchronization Techniques for Redundant Processing," The Institute of Electrical and Electronics Engineers Workshop on Distributed Systems, Purdue University, West Lafayette, Indiana, 5 October 1986.

PITTELLI, Frank M., Assistant Professor, "Redundant Database Processing," BBN Advanced Computers, Inc., Boston, Massachusetts, 27 February 1987.



Mathematics

PROFESSOR FREDERIC I. DAVIS
CHAIRMAN

Perusing the contents of this report, one is struck by the variety of its subjects. Yet this should not be very surprising. Mathematics is, after all, the common language of science and engineering, and its applications grow every day. Living in symbiosis with many other disciplines, it derives sustenance from them and returns to them greater comprehension. In addition to research in applied mathematics, a *considerable amount of the Department's scholarly effort* is devoted to pure mathematics, that field which advances our understanding of mathematics itself.

While some of the work summarized here was undertaken independently, support has been gratefully received from several sponsoring agencies. These include the Office of Naval Research, the David W. Taylor Naval Ship Research and Development Center, and the National Science Foundation.

This research enhances the stature of the Naval Academy as an academic institute and adds to the reputation of those engaged in it. It also adds to the professional life of the Department and to teaching effectiveness. Involvement in the process of personal intellectual discovery increases one's awareness of the excitement and difficulty of learning.



Sponsored Research

Approximately Finite Dimensional C^* -Algebras

RESEARCHER: ASSISTANT PROFESSOR B. MITCHELL BAKER

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

The investigator has been studying the relationships among approximately finite-dimensional C^* -algebras, random walks on the lattice of integers (\mathbb{Z}), and the K_0 -theory of compact group actions on such algebras. The basic idea is to characterize the ring K_0 associated with the fixed-point algebra (i.e., the subalgebra of elements invariant under the chosen group action) together with its order structure: namely, a positive cone (K^+) and an order unit (1). The $(K_0, K_0^+, 1)$ is known to be a complete isomorphism invariant for the fixed-point algebra, as well as a conjugacy invariant for the group action. Working in conjunction with D. E. Handelman, the investigator has identified the difficult part of this

problem – the complete characterization of K_0^+ in computable fashion. This “positivity problem” has been shown to correspond to certain asymptotic properties of an associated \mathbb{Z} -valued random walk. For a large class of such random walks (corresponding to actions on the 1-torus), this problem has been solved. For actions of the rotation group $SO(3, \mathbb{R})$ or actions on the n -torus T^n , many of the questions remain open. The investigator seeks to extend this work to these (higher-dimensional) random walks. Finally, he is currently exploring the connection between these random walks and certain classical spin models of statistical mechanics, particularly with regard to phase transitions.

Numerical Determination of the Moduli of Viscoelastic Materials

RESEARCHER: ASSOCIATE PROFESSOR JAMES L. BUCHANAN

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The response of a viscoelastic material to vibration is characterized by two moduli, the dynamic Young's modulus and the loss modulus, both of which vary with the frequency of vibration. At the David W. Taylor Naval Ship Research and Development Center, a project is currently underway to calculate these parameters for a wide range of materials. The calculation of the moduli is obtained by solving a system of transcendental equations numerically. Previously, the investigator developed numerical techniques for reliably finding the physically rele-

vant solution and estimating numerically the effect of measurement errors on the calculated values of the moduli. The results of this work will appear shortly in the *Journal of the Acoustical Society of America*. Currently, the investigator is developing an integrated software package for the computation and analysis of the input data, the moduli, and quantities of physical interest which are calculable once the moduli are known. Also, explanations are being sought for anomalies which have been observed in the experimental data for certain materials.

Graph Theory, Machine Vision, and Image Recognition

RESEARCHER: ASSOCIATE PROFESSOR CAROL G. CRAWFORD
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
CARDEROCK LABORATORY

A major goal of this ongoing research project has been the development of mathematical theories to aid robots in recognizing solid objects. The researcher has developed efficient algorithms to transfer geometric information directly and automatically from a solid modeler such as PADL2 to a robot vision system. The technique used in the creation of these algorithms is based on encoding geometric

information on solids in structures called aspect graphs. The aspect graph then becomes part of a world model which is referenced by the robot vision system. Current investigations by the researchers have extended this work to applications in the evaluation, specification, and design of machine vision systems and the problem of image recognition.

Resonance Spectra of Elongated Elastic Objects

RESEARCHER: PROFESSOR JAMES M. D'ARCHANGELO
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The objective of this ongoing project is to model mathematically the response of smooth elastic objects caused by the incidence of an acoustic wave. The principle that the resonances are caused by the phase matching of surface waves which thereby form standing circumferential waves has been investigated for spheres and infinite cylinders. Here, the researcher extends the phase matching principle to finite elongated elastic objects such as prolate

spheroids and cylinders with hemispherical endcaps.

The investigator represents the phase velocity of the surface wave at each point of the object's surface by that of the known surface wave on a sphere with the same radius of curvature. An extension of this approach to the resonances of surface waves of Whispering-Gallery type, and to non-meridional, i.e., helical or quasihelical propagation, is now in progress.

Predicting Life Expectancy of Antifouling Coatings

RESEARCHER: ASSISTANT PROFESSOR GARY O. FOWLER
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCHER AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The David W. Taylor NSRDC performs static tests of the life expectancy of potential antifouling coating for the U.S. Navy. Panels are treated with the antifouling coating and submerged at various test sites. Quarterly reports are made regarding the performance. Two problems associated with these tests are analyzed in this research. The antifouling coatings are good enough to prevent all fouling for as long as four years. It would be useful to estimate from early data how long the coatings will be effective, so that preliminary decisions could be made without waiting for the tests to be completed. The

second problem is one of quality control. Errors are made in judging and in reporting the performance of the coatings. Some of these could be corrected if reliable estimates of the expected performance were known in advance.

Parametric statistical models for the performance of the coatings have been constructed. Data are becoming available for validating the proposed models. The models will estimate confidence intervals for the time to specified levels of fouling. They will also estimate confidence intervals for the fouling levels at specified times.

Constraints and Momentum Mappings in Relativistic Field Theory

RESEARCHER: ASSISTANT PROFESSOR MARK J. GOTAY
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

In classical field theories the Euler-Lagrange equations typically split into hyperbolic evolution equations and elliptic constraint equations. This division is accompanied by a rich symplecto-geometric structure which, in most cases of physical interest, can be directly ascertained by analyzing the relevant gauge symmetries. The purpose of this project is to study the relations among gauge groups, momentum maps, and constraints.

The main theorem shows that the constraint set for such theories may be identified with the zero-level set of the momentum mapping associated to

the gauge group. This result, along with a splitting of the fields into dynamic fields and nondynamic "atlas" fields which drive the gauge freedom of the system, enables one to cast the dynamics into adjoint form on the symplectic space of dynamic fields and their conjugate momenta. This, in turn, is very useful for discussing questions of linearization stability, gauge fixing, and the structure of the space of solutions of the evolution equations.

Several examples are also presented: Maxwell electrodynamics, Einstein gravity, parametrized particles, and string theories.

Reduction for Singular Momentum Mappings

RESEARCHER: ASSISTANT PROFESSOR MARK J. GOTAY
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

There are several ways of reducing a constrained system with symmetry: algebraically, group-theoretically, geometrically, and *a la* Dirac. Various methods work under differing circumstances, while the others often give spurious results. The goal here is to provide conditions under which all methods make sense and agree.

Thus far, general theorems have been proven

which answer such questions in the abstract. The problem now is to come up with simple, easily verifiable criteria in specific cases, and also to determine to what extent *these theorems can be generalized*. These problems have been for the most part solved when the symmetry group is compact or when a group-invariant metric exists for the system; counterexamples have been provided in other cases.

The Fixed Point Property, Noncoincidence Index, and Free Group Actions

RESEARCHER: ASSISTANT PROFESSOR MICHAEL E. HOFFMAN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

A topological space has the fixed point property (FPP) if every self-map of the space has a fixed point. The investigator has defined a topological invariant, the noncoincidence index, which measures the departure from the FPP: it is $1+m$, where m is the maximal cardinality of a set of fixed-point-free self-maps of the space, such that no pair have a coincidence (so a space has non-coincidence index 1 if and only if it has the FPP). The investigator has been seeking relations among the noncoincidence index of a topological manifold and its other invariants, e.g., its Euler characteristic and Betti numbers. He has also been interested in the way that the noncoincidence index behaves with respect to free group actions and in the homological obstructions to the existence of free group actions.

The investigator was able to characterize those compact oriented manifolds with finite noncoincidence index: they have nonzero Euler characteristic and admit no degree zero self-maps without fixed points. For such manifolds, the noncoincidence index is bounded by the sum of the squares of the

Betti numbers. He also obtained relations between the noncoincidence index of a manifold with a free group action and the noncoincidence index of the orbit space: in particular, if M is simply connected and a finite group acts freely on M , then the orbit space has the FPP if the order of the group is equal to the noncoincidence index of M . The noncoincidence index can be computed fairly easily for those manifolds in which the endomorphisms of the rational cohomology are classified; this includes familiar spaces such as spheres and projective spaces, as well as many spaces of the form G/K , where G is a compact Lie group and K is a closed connected subgroup of maximal rank. Spaces with finite noncoincidence index have many geometric rigidity properties and usually have strong obstructions to free group actions.

The investigator has written two papers about free group actions on a product of spheres; the first has been accepted for publication and the second has been submitted. The investigator is currently preparing a paper on the noncoincidence index.

Orthogonal Polynomials Associated with Reflection Groups

RESEARCHERS: ASSISTANT PROFESSORS MICHAEL E. HOFFMAN
AND WILLIAM D. WITHERS
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

As a starting point, the investigators considered a shape in \mathbb{R}^n that can be folded into smaller replicas of itself. Examples of such shapes are a cube, an equilateral triangle, and a right isosceles triangle. For each such shape they sought a sequence of polynomials that can be transformed by an appropriate change of coordinates into the functions describing the folding of the shape into itself. The simplest case—an interval in \mathbb{R} —gives rise to the Chebyshev polynomials. Since each shape foldable into replicas of itself corresponds to a group of symmetries (an affine Weyl group), to construct polynomials for each shape it is enough to do so for each group.

Using the well-known classification of affine

Weyl groups, the researchers have constructed polynomials associated with all affine Weyl groups in any number of dimensions. Using the theory of affine Weyl groups, the researchers have found for each family of polynomials recurrence relations, orthogonality relations, composition properties, differential equations, and properties of the polynomials as dynamical systems.

This theory has connections with the theory of Lie algebras and potential applications to statistical mechanics. The researchers are currently investigating polynomials associated with reflection groups on non-Euclidean spaces.

Research Into the Joint Applications of the Theory of Semigroups With the Theory of Fuzzy Sets to Problems in Pattern Recognition

RESEARCHER: ASSOCIATE PROFESSOR BAO-TING LERNER
SPONSOR: NATIONAL SCIENCE FOUNDATION

The objective of this project is to investigate and develop the joint applications of the theory of semigroups with the theory of fuzzy sets to provide solutions to problems in pattern recognition and computer vision. Using the techniques and results of fuzzy set theory, the problem of inferring the nature or shape of an object from incomplete or imprecise sensory data is being studied.

Recently, there have been considerable efforts to build computer vision systems which have the capability to describe objects and their interspatial relations. The main thrust of these systems is to derive

3 dimensional information about the objects from their 2-dimensional visual images. However, the problem of analyzing these images is compounded by complex and imprecise data arising from factors such as illumination, viewing angles, and topological properties of objects. Fuzzy set theory affords an effective methodology for dealing with such imprecision and complex processes.

Three pattern recognition problems and their solutions in terms of the concepts of fuzzy sets and semigroups are outlined as specific research tasks.

Shifts on C^* -Algebras

RESEARCHER: ASSOCIATE PROFESSOR GEOFFREY L. PRICE
SPONSOR: NATIONAL SCIENCE FOUNDATION

A shift α on a C^* -algebra A is a $*$ -endomorphism of A which is a monomorphism, is unital, and satisfies $\bigcap_{n=1}^{\infty} \alpha^n(A) = \{0\}$. An important feature of a shift is the fact that the image algebra $\alpha(A)$ is a subalgebra of A isomorphic to A . In the case where A is a factor (a von Neumann algebra with trivial center), $\alpha(A)$ is a subfactor, and one may use the recent index theory of Jones to compute the index $[A:\alpha(A)]$ of $\alpha(A)$ in A . For example, in the case where A arises as the completion of the tensor product construction $A = \bigoplus_{k=1}^{\infty} M_k$, where each M_k is an $n \times n$ matrix algebra, the shift $\alpha(A) = I A$ has index n^2 .

The investigator's recent work has centered on shifts analogous to shift operators on a Hilbert space. Let u_1, u_2, \dots each be unitary operators, with the properties that a) $u_k^n = I$, for all k in N , some fixed n ; b) $u_k u_1 = s(k-1) u_1 u_k$, where s is a function

from Z to the n th roots of unity. Define a shift α on the algebra A , generated by the u_i 's by $\alpha_i(u_i) = u_{i+1}$. Necessary and sufficient conditions for the algebras A , to be simple have been determined. Moreover, the investigator has determined that the mapping s is a complete conjugacy invariant for shifts α , defined on the unique hyperfinite II_1 factor $R = A_\infty$, as above.

There are numerous avenues yet to pursue. The investigator is presently looking at shifts α in $C(X, B(H))$, the algebra of continuous functions from a compact space X into $B(H)$. If α commutes with the trivial $C(X)$ -action, then α splits as a shift $\bigoplus_{i \in X} \alpha_i$. It has been determined that the index $[B(H): \alpha_i(B(H))]$ is a local invariant. The researcher hopes to investigate the structure of the conjugacy classes of such shifts.

Paradimension

RESEARCHER: ASSISTANT PROFESSOR WILLIAM D. WITHERS
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

In the study of dynamical systems, many quantities are found to scale according to a power relation. The exponent in such a relation, although often not an integer, is called dimension, being analogous to the integral dimension found in classical problems. For example, if $B(x, \epsilon)$ is the ball of radius ϵ around some point x on the attractor for a dynamical system, and μ is the natural invariant measure for the system, there often exists a number D independent of x such that

$$\lim_{\epsilon \rightarrow 0} \frac{\log \mu B(x, \epsilon)}{\log \epsilon} = D$$

and D is called the dimension of μ . Based on the above equation, one might estimate $\mu B(x, \epsilon) \sim \epsilon^D$ for small ϵ .

A careful analysis of a particular class of systems

has revealed that the graph of $\log \mu B(x, \epsilon)$ as a function of $\log \epsilon$ resembles a random walk, or a stochastic process, as $\epsilon \rightarrow 0$. The dimension D is analogous to the mean of the stochastic process, which is an important aid in analyzing the character of the system. The researcher calls the quantity P the paradimension.

The researcher has investigated means of calculating the paradimension and obtained the following volume lemma:

$$P = \lim_{\epsilon \rightarrow 0} \sup \frac{\log \mu B(x, \epsilon) - D \log \epsilon}{\log(1/\epsilon) \log \log \log(1/\epsilon)}$$

This implies that ϵ^D is actually a rather poor estimate for $\mu B(x, \epsilon)$, and it gets worse as $\epsilon \rightarrow 0$. Just how bad this estimate is depends on the value of P .

The Battleship Battlegroup: An Operations Analysis

RESEARCHER: MIDSHIPMAN I C MICHAEL C. CLARK
ADVISERS: COMMANDER JOHN M. COCHRANE, USN AND
LIEUTENANT MICHAEL SCHWARTZ, USN (SEAMANSHIP AND NAVIGATION)
SPONSOR: TRIDENT SCHOLAR PROGRAM

This paper considers the battleship as the high value unit in a Battleship Battlegroup (BBBG). The importance of the battleship's firepower, speed, and survivability is discussed, as are its limitations in anti-air and anti-submarine warfare capabilities.

Employment of the battlegroup is viewed in the context of the three phases of the Maritime Strategy. Scenarios are presented that would likely be encountered in a global, conventional war in which both superpowers would be aided by their allies. Certain geographic areas were considered optimum for the BBBG because of a low air threat and/or a low to medium submarine threat and their importance to the Maritime Strategy. The Caribbean Sea and the South China Sea were the scenarios tested.

Escorts for the battleship are separated into two proposed groups: a high and low mix. The high mix of ships is that which provides maximum capability without regard to the number of ships in the formation. The low mix of ships is that which represents the minimum required for mission success.

Testing was conducted on the Naval Tactical Gaming System at the U.S. Naval Academy. The

two classifications of battle group, both high and low, as well as the Chief of Naval Operations' proposed notional BBBG, were tested against a mix of expected Soviet and Soviet bloc adversaries. They represented the worst possible case of ships, aircraft, and submarines that could be encountered in each area of operation. The CNO's BBBG was tested to determine its relationship to the high and low mixes of this study.

The objective for the BBBG in the scenarios was to reach the conventional Tomahawk Land Attack Missile launch point. Conclusions were drawn based on the number of ships remaining in the battlegroup once launch point was reached and on the ability of the BBBG to defend itself thereafter.

In the Caribbean Sea Scenario, the low mix performed poorly, the CNO's mix favorably, and the high mix excellently. In the South China Sea, the low mix was devastated while the CNO's and the high mix performed unfavorably.

The overall conclusion is that the BBBG is a feasible concept when used in the proper scenario with the right escorts.

Independent Research

Datum Clearing

RESEARCHER: PROFESSOR PETER P. ANDRI

A Submersible Ship Ballistic Nuclear (SSBN) must occasionally emit a loud noise which makes it vulnerable to detection by a distant enemy. After the SSBN stops a noisy evolution, it resumes its earlier quiet state and it must then try to avoid redetection.

The purpose of this study is to give tactical suggestions to the commander of the SSBN to help him avoid being redetected by an enemy platform. The

optimal strategy for the commander is a radial flight from the datum (noise emission point) with a speed which depends on the rate at which his noise increases with speed and on the dependence of the propagation loss of sound transmission with distance. Tactics which involve any turns will increase the probability that the enemy platform will pass within a given distance of the SSBN.

Optimizing Number of Bacteria Killed, A Combinatorial Model

RESEARCHER: ASSISTANT PROFESSOR CRAIG K. BAILEY

A colony of bacteria is compartmentalized and antibiotic is applied to each compartment. How is the number of bacteria killed affected by the number of compartments used? With reasonable assumptions from empirical data, it is desirable to determine the number of compartments in order to maximize the number of bacteria killed.

According to one model, the integer inequality $y \cdot x^y(y^x - (y-1)^x) > xy^y(x^x - (x-1)^y)$ if true for $x > y > 1$, would show that the optimal number of compartments is constrained by a boundary condition.

A proof of the inequality was found using the binomial theorem, but a combinatorial proof more directly related to the problem is still sought.

Time Dependent Integer-Valued Random Walks, Eventual Positivity of Polynomials, and the K_0 Theory of Product Type Actions of the Torus

RESEARCHER: ASSISTANT PROFESSOR B. MITCHELL BAKER

In this work the researcher considers several equivalent problems:

- (1) multiplication of polynomials to obtain positive coefficients;
- (2) convolution of members of a sequence of \mathbb{Z} -valued random walks with a fixed element;
- (3) asymptotic properties of conditional probability distributions associated with a sequence of time-dependent \mathbb{Z} -valued random walks; and
- (4) the K_0 theory of certain C^* -algebras arising as fixed-point subalgebras under product type actions of the one-torus.

This problem was motivated by the study of approximately finite-dimensional C^* -algebras. In particular, the ordered K_0 -theory of such algebras yields an ordered module which comprises both an isomorphism invariant for the algebras and a complete invariant for conjugacy of a corresponding rotation group action. The problems mentioned above are equivalent to characterizing the order structure of K_0 , and hence the associated isomorphism and conjugacy invariant. For a large class of approximately finite dimensional C^* -algebras, a computable characterization of the ordered K_0 module is obtained.

Analysis of the Equations of a Vibrating Thermoelastic Plate

RESEARCHER: ASSOCIATE PROFESSOR JAMES L. BUCHANAN

The starting point of this work was a paper by Friedrichs and Dressler in which an asymptotic analysis of the equations governing the static equilibrium of an elastic three-dimensional material was used to derive the partial differential equation and Kirchhoff boundary conditions for a plate, and to demonstrate the presence of edge effects without appeal to exogenous axioms such as Saint-Venant's principle. The investigator and two co-workers, R. P. Gilbert and R. Manganini², extended this analysis

to the case of a plate with a thermal term undergoing steady state vibration. Partial differential equations for the first order deflection and temperature were obtained. It was shown that the Kirchhoff boundary conditions remain valid, and that a similar mean temperature and edge effect formulation was appropriate for the boundary condition for temperature. Also, it was found that known equations for thermal effects on boundary bending moments followed naturally from the analysis.

Near Chromatic Polynomials

RESEARCHER: ASSOCIATE PROFESSOR CAROL G. CRAWFORD

An almost proper line coloring of a graph is a coloring of the edges such that at each vertex at most two adjacent edges are colored the same. The near chromatic polynomial $N(G; x, y)$ is a polynomial which gives the number of almost proper line colorings of

a graph G . The researcher has developed algorithms for the determination of these polynomials. Various properties of the polynomials have also been explored, along with applications to experimental design problems.

Polynilpotent Products

RESEARCHER: ASSOCIATE PROFESSOR ANTHONY M. GAGLIONE

Let G_m denote the m^{th} member of the lower central series of a group G defined inductively as $G_1 = G$ and if $n > 1$, $G_n = [G_{n-1}, G]$. If $m_1, m_2, \dots, m_k, \dots$ is a given sequence of positive integers, then $G_{m_1 \dots m_k}$ denotes a subgroup also defined inductively: $G_{m_1 \dots m_k} = [G_{m_1 \dots m_{k-1}}, m_k]$ is the m_k th member of the lower central series of the group $G_{m_1 \dots m_{k-1}}$ if $k > 1$.

A group G is called *polynilpotent* if $G_{m_1 \dots m_k} = \{1\}$ for some sequence m_1, \dots, m_k . All such groups form a variety γ of polynilpotent groups determined by the sequence m_1, \dots, m_k which is representable as the product

$$\gamma = N_{m_{k-1}} N_{m_{k-1} \dots m_{k-2}} \dots N_{m_1}$$

where N_c denotes the variety of all nilpotent groups of class $\leq c$.

The free groups of the variety γ are called *free polynilpotent groups*. A free polynilpotent group is representable as a factor group $P \approx F / F_{m_1 \dots m_k}$ of a free group F of the same rank as the group P .

Polynilpotent groups have been well studied. In particular, the quotient groups of the lower central series of P and $P_{m_1} P_{m_2} \dots P_{m_{k-1}}$ are known and are finitely generated free Abelian groups. This research project centers on the following:

- (1) construction of bases B_m for $P_{m_1} P_{m_2} \dots P_{m_{k-1}}$;
- (2) proof that the B_m are in fact bases; and
- (3) derivation of formulas for the number of elements in B_m ; i.e., the ranks of $P_{m_1} P_{m_2} \dots P_{m_{k-1}}$.

Multisymplectic Structures in the Higher Order Calculus of Variations

RESEARCHER: ASSISTANT PROFESSOR MARK J. GOTAY

The calculus of variations for higher order Lagrangians is not nearly as well understood as in the standard first order case. Three fundamental concepts need to be elucidated: (1) the covariant phase space, (2) the covariant Legendre transformation, and (3) covariant regularity. The purpose of this research is to define appropriately and develop these concepts.

Regarding (1), a good candidate for the covariant phase space has been discovered. The investigator has shown that it carries a canonical multisymplectic structure which gives rise to the correct symplectic structure on the space of Cauchy data for the evolution equations.

For (2), a method of constructing the covariant Legendre transformation has been given, but it is not unique. It remains to determine the implications of this non-uniqueness.

In (3), a suitable definition of covariant regularity has been given. It is now necessary to compare this with other such definitions in the literature and to determine what happens in the singular case.

Research on these topics is currently in progress. Also, several examples, such as the KdV equation and general relativity are being analyzed.

Generating Elements of $\text{Pic}(R)$

RESEARCHER: ASSOCIATE PROFESSOR CHARLES C. HANNA

An R -module M is strongly two-generated if it can be generated by two elements, the first of which can be any non-zero element of M . Lantz and Martin show in a recent preprint that every strongly two-generated fractional ideal is invertible, and that the collection of strongly two-generated invertible ideals induces a subgroup of $\text{Pic}(R)$.

The purpose of this research is to extend these ideas to a broader class of R -modules. *Definition:* Let P be a property of subsets of rank one projective R -modules. An R -module M is $P+1$ generated if it contains a subset with property P and, if S is any subset of M with property P , then there exists some element of p of P such that P can be generated by S and p .

Definition: Let C be a collection of invertible ideals or of rank one projective R -modules. A prop-

erty P of subsets is C -transferable if for any P and Q in C and any subsets S of P with property P there is some set of R -homomorphisms from P to Q , indexed by S , such that the subset of Q obtained by applying to each element of S the corresponding homomorphism also has property P .

Theorem: If C is any collection of invertible ideals or of rank one projective modules whose isomorphism classes form a subgroup of $\text{Pic}(R)$, and property P is C -transferable, then the collection of $P+1$ generated elements of C induces a subgroup of $\text{Pic}(R)$.

These results generalize the work of Lantz and Martin, and give additional information about several previously defined collections of invertible ideals. The project is essentially complete, and the results are being prepared for publication.

An Elementary Infinitesimal Proof of the Fundamental Theorem of Algebra

RESEARCHER: ASSOCIATE PROFESSOR ROBERT A. HERRMANN

In this research the researcher applies elementary infinitesimal nonstandard analysis to establish without application of compactness, continuity, or integral concepts the fundamental theorem that for any polynomial $P(z)$, with complex coefficients, there

exists a complex number r such that $P(r)=0$. The significance of the methods utilized are that they may be employed at the conclusion of an ordinary introduction to modern infinitesimal calculus at the level of Keisler's "Elementary Calculus."

NPS-World Derivations

RESEARCHER: ASSOCIATE PROFESSOR ROBERT A. HERRMANN

In this project, the researcher formally and rigorously established the conclusions stated in the published paper, "D-world Evidence." In particular, he studied the deductive system S_0 and its associated ultralogic $*S_0$, nonstandard algorithms and their relation to such theories as formal Peano arithmetic. He rigorously establishes the theoretical existence of the ultra-subparticle and gives an explicit mech-

anistic process that utilizes the hypervolume combination operator and yields the N-world formation of any material particle, as well as various dense substratum wave fields. These results also yield mechanistic explanations for the concept of the quantum transition among many other aspects of subatomic activity.

Subparticles and the Special Theory

RESEARCHER: ASSOCIATE PROFESSOR ROBERT A. HERRMANN

In this research the investigator employed the subparticle property of monadic clustering in order to establish a subparticle cause for all of the apparent effects predicted by the Special Theory of Relativity. In particular, it is assumed that any position from or throughout which an electromagnetic effect appears to propagate, when viewed from the NSP-world, is embedded in a disjoint monadic cluster of substratum subparticles where this monadic cluster mirrors the same unusual order properties with respect to propagation as the nonstandard order of the nonarchimedean field $*R$ and the propagation

properties within each monadic cluster are identical. It is also assumed that within such a cluster, propagation properties within each monadic cluster are identical. Further, it is assumed that within such a cluster propagation is linear and follows the classical concepts of Gallilian composition and the well-known infinitesimal process of indistinguishable effects. From these simplistic assumptions the differential equation of Prokhovnik is obtained, and from this equation, coupled with the concept of Einstein measures, the entire Special Theory is obtained.

The Combinatorics of Link Polynomials

RESEARCHER: ASSOCIATE PROFESSOR MARK E. KIDWELL

The author's joint project with Jim Hoste of Oregon State University continues. The researchers are attempting to find all invariants of links with two colors which generalize both the classical Alexander polynomial $A(t_1, t_2)$ and the recently-discovered generalization $P(v, z)$ of the Jones polynomial. They seem to have succeeded in the case where one color is used

only for one unknotted component of the link.

Generalizations in a previous paper will require the author to learn more about the Tutte polychromatic polynomial, probably with the aid of graph theorists in the Naval Academy Mathematics Department.

Weakly Stiffened Plates

RESEARCHER: ASSISTANT PROFESSOR THOMAS L. MAHAR

The purpose of this research was to determine the effect of weak stiffeners on the buckling load and deformation of a plate subject to an edge thrust. Of particular interest is the optimal placement of the stiffening material, so as to effect the largest increase in the buckling load or the largest reduction of the deformation.

The first part of the study used variational methods to derive the appropriate equations. The cases of attached and unattached stiffeners were treated separately. The second part of the study consisted of constructing asymptotic expansions for the buckling load and deformation. The ratio of the

area of stiffening material to the total area of the plate was used as the small parameter. A special asymptotic procedure was devised to treat this type of problem.

The third part of the study was an analysis of the variation of the buckling load and deformation as the location of the stiffening material was varied. This information was used to optimize the location of the stiffening material.

These results were derived in joint work with W. T. Grayhack of Northwestern University. Two manuscripts are in preparation.

Dynamical Systems and Probability

RESEARCHER: ASSISTANT PROFESSOR PAUL B. MASSELL

The researcher's goal was to design a survey course on dynamical systems which emphasizes the probabilistic aspects of that field. The purpose of such a course is to integrate ideas from the classical theory of differential and difference equations (e.g., equilibria, stability) with modern ideas (e.g., bifurcations, chaotic maps, fractal geometry) and with ideas from the theory of stochastic processes (Markov chains, entropy, random walk, Brownian

motion). The researcher feels that such a survey course will provide the students with a broad perspective on possible ways to model physical systems; in particular, an introduction to the important new ways that the notion of chaos now appears in the description of such systems. Such a course was taught to one midshipman in Spring 1987 as SM486C. Much further development remains.

Fractals

RESEARCHER: ASSOCIATE PROFESSOR MARK D. MEYERSON

Fractals is a mathematical term coined by Mandelbrot for sets with certain striking properties. Usually it is taken to mean either a set of fractional, non-integer, dimension (hence the name), or a set with certain properties of self-similarity. Drawings of these sets can be strikingly beautiful. They have applications in the field of dynamical systems.

Of special interest are certain topological and geometric questions about fractals. Topological questions include: Is a given fractal set connected? simply connected? a simple closed curve? Geometric questions include: What is the (fractional) dimension? what self-similarities are there?

Local Factors for Covering Groups of $GL(2)$

RESEARCHER: ASSISTANT PROFESSOR COURTNEY H. MOEN

This project analyzes in detail the L and E-factors for some particular representations of the 3-sheeted covering groups of $GL(2)$ over local fields and adeles of a number field. The main objective is to discover if the local and global factors respect the Shimura correspondence. The first problem to overcome is that the Weil representation, which was used to calculate factors for 2-sheeted covers, is not available

for 3-sheeted covers. This difficulty has been overcome by constructing an explicit realization for the representations as images of intertwining operators. Using these realizations, the local factors have been calculated explicitly. The connection with Shimura correspondence has not yet been completely worked out.

On the Brown-Peterson Homology of $BP_* (B\mathbb{Z}/p^n, nB\mathbb{Z}/p)$

RESEARCHER: ASSISTANT PROFESSOR GEORGE NAKOS

The research under the above title has resulted in a manuscript submitted for publication in the *Transactions of American Mathematical Society* and is currently being revised for resubmission. It is essentially the researcher's doctoral dissertation (first chapter, written under the guidance of Professor M. Boardman, Johns Hopkins). The mathematical problem solved in this project is the following: One effective way of studying group actions of manifolds

in Algebraic Topology is the use of various generalized homology and cohomology theories. One of the most successful of such theories is the Brown-Peterson theory. Quite a few geometric problems reduce to the computation of the Brown-Peterson homology of certain classifying spaces BG (G is a group). This research solves the problem when $G = \mathbb{Z}/p \times \mathbb{Z}/p^n$ (The integers mod p and Adams Spectral Sequence).

Use of Computers in the Teaching of Mathematics

RESEARCHER: ASSOCIATE PROFESSOR HOWARD L. PENN

The purpose of this project is to investigate the use of computers in the teaching of mathematics. The use of both commercially available and locally produced software is being considered. The investigator has produced computer programs that are used in the teaching of differential equations and calculus. These include programs on the spring vibrations and the one-dimensional wave equation which illustrate two applications of differential equations

and a program on polar coordinate graphs. Work with several other instructors continues on an EGA graphics package. The researcher has reviewed nearly all computer packages available for the teaching of differential equations and many of the commercially available programs for the teaching of calculus. This project is being continued in 1987-1988 under a joint Instructional Development Project with Assistant Professor Craig Bailey.

A Quadratic Form Associated to Quadratic Mappings of Spheres

RESEARCHER: ASSOCIATE PROFESSOR JOANN S. TURISCO

Given a continuous map $f: \mathbb{R}^n \rightarrow \mathbb{R}^m$, one may associate a quadratic form in the following way:

$$M(f) = (m_{ij}), \text{ with } m_{ij} = \frac{m}{a_{n-1}} \int S f_i f_j dw$$

where dw is the standard Haar measure on the unit spheres S^{n-1} and a_{n-1} is the surface area of S^{n-1} ($1 \leq i, j \leq m$). Of particular interest is the case where $f: S^{n-1} \rightarrow S^{m-1}$ is a mapping of spheres of the Hopf type. If f is one of the classical Hopf fibrations, then $M(f)$ is a sum of squares. (T. one) If f is defined over the integers, then $M(f)$ is a diagonal form over the

rational numbers. If f is a mapping of spheres, then the form $M(f)$ is always positive semi-definite, and positive definite if f is an integral Hopf map. Hence the forms $M(f)$ are all isometric over the real numbers in this case. The investigator is currently examining the isometry classes of $M(f)$ over the integers, where f is an integral Hopf map.

These results are written up in a paper entitled "A Note on A Quadratic Form Associated to Hopf Maps" which has been submitted to Professor Olga Taussky-Todd for publication in *Linear Algebra And Its Applications*.

Canonical Forms for Integral Matrices Under Similarity

RESEARCHERS: ASSOCIATE PROFESSOR WILLIAM P. WARDLAW AND
ASSISTANT PROFESSOR R. BRUCE RICHTER

The goal of this research, which was begun in the Fall of 1985, is to determine a collection of readily recognizable $n \times n$ matrices (the canonical forms) with the property that any $n \times n$ matrix with integer entries is integrally similar to *exactly one* of the matrices in the given collection. The researchers

have generalized some of their results for matrices similar to a diagonal matrix to matrices over arbitrary commutative rings. Investigation continues of integer matrices which are not integrally similar to a diagonal matrix.

Integer Programming

RESEARCHER: ASSOCIATE PROFESSOR CARVEL S. WOLFE

The purpose of the project is to solve general scheduling problems involving a circulant coefficient matrix. The difficulty of the problems increases with the number of blocks of consecutive ones in any column of the circulant matrix. The case of one block is essentially solved by linear programming. Cases for two and four blocks were considered and solved with special heuristic algorithms by researchers from the Indian Institute of Technology, Kanpur, India, in 1985. Ten example problems similar to those in the Indian paper were generated in each of ten problem types, ranging from a 24×24 to a 72×72 coefficient matrix. These problems, where workers are intermittently available and re-

quirements are cyclic in nature, have been shown to be NP-complete.

The branch and bound method with penalties could handle only a few of these problems, due to the large number of tying nodes. A cutting plane code did very well in the case of two blocks of ones per column, solving all but one of 50 problems generated.

In the case of four blocks of ones, the cutting plane code ran into convergence trouble, due to degeneracy, and solved only 57% of the problems tried. In convergent cases the cutting plane code is easier and quicker than other algorithms. A convergence theory or predictor is needed.

Research Course Projects

Computer Simulation of an Inertial Flight Instrument

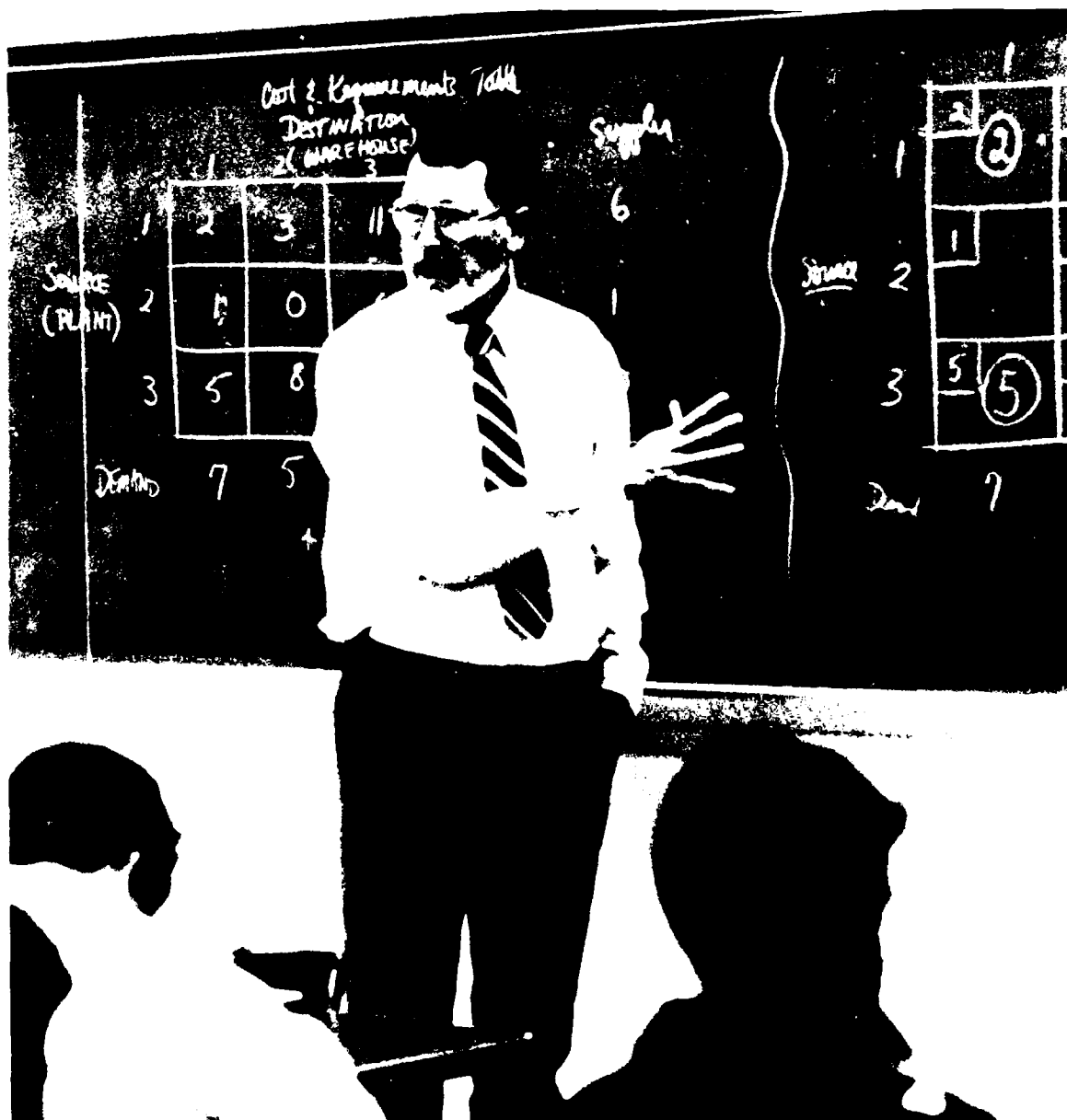
RESEARCHER: MIDSHIPMAN 1 C JEFFREY E. LAY

ADVISOR: PROFESSOR THOMAS J. SANDERS

The purpose of this project was to develop a computer model of an artificial horizon indicator that could be used in a modern flight simulator.

The artificial horizon indicator is one of the inertial flight instruments that is crucial to a pilot's ability to maneuver his aircraft. It serves as a device

to indicate the aircraft's attitude relative to the horizon. A mathematical model was developed to provide a simulation of this instrument. A computer program was then written to use the model to simulate the output from the instrument during a simple flight regime.



Publications

CRAWFORD, Carol G., Associate Professor, "Graph Theory, Machine Vision and Image Recognition," David W. Taylor Naval Ship Research and Development Center, Technical Report, June 1987.

This paper presents results of a continuing research project in developing algorithms to aid robot vision systems in solving the significant problem of object recognition. Extensions of previous results in aspect graph generation are included, with applications to the design of machine vision systems in general.

DARCHANGELO, James M., Professor, co-author, "Resonance Spectra of Elongated Elastic Objects," *Journal of the Acoustical Society of America* 81, 2 (February 1987), 312-316.

The eigentrequencies at which smooth convex objects resonate under the incidence of an acoustic wave correspond to the real parts of those complex frequency values at which circumferential waves generated by the incident signal phase-match after repeated circumnavigations around the object. A resonance condition based on this principle is formulated, and applied to the case of elastic prolate spheroids and cylinders with hemispherical endcaps. Using the known phase velocities of surface waves on elastic spheres, with a radius equal to the local radius of curvature along the surface path, the elastic resonance frequencies of these objects can be predicted. This was done for the Rayleigh wave on a prolate spheroid, where comparison with resonances in the scattering amplitude as obtained by a T-matrix calculation led to good agreement.

FOWLER, Gary O., Assistant Professor, "Determining the Existence of Bimodal Distributions in Data from Static Panel Immersion Testing," Ship Materials Engineering Department Research and Development Report DTNSRDC SME 86 43, September 1986.

Research into the development of improved antifouling shipbottom coating makes extensive use of static panel immersion tests to screen developmental materials. A currently useful procedure is to expose twelve to twenty 10" by 12" test panels coated with the developmental coating at one or both of the Navy's exposure sites (Miami and Pearl Harbor). These panels are evaluated on a quarterly basis to estimate the amount of fouling as a measure of effectiveness. It has been observed that the fouling times for some samples of antifouling coatings exhibit a bimodal distribution. It is believed that this can be explained by viewing the sample as coming from two different populations, rather than the usual view that the sample comes from a single population. An algorithm is presented that is capable of detecting bimodal distributions. It is tested using Monte Carlo simulations. In addition, estimates are calculated of the separation between two binomial distributions required for their mixture to be bimodal.

GAGLIONE, Anthony M., Associate Professor, co-author, "Commutator Identities Obtained by the Magnus Algebra," *Houston Journal of Mathematics*, 11, 4 (1985), 491-504.

This paper contains generalizations of commutator identities of Philip Hall for such expressions as $[a, b^{p^n}]$ and $(ab)^{p^n}$ in a free group F , where for $x, y \in F$ $[x, y] = x^{-1}y^{-1}xy$ and p is a prime number and $\alpha \geq 1$. These generalizations lie partly in the estimates made for the exponents on the basic commutators in the basic commutator representations of these group elements. The method used is that of the modern commutator calculus. This means that the free group F is embedded in a formal power series ring M (the Magnus Algebra) and then the computations are done in M . The advantage to be gained from this procedure is that it reduces the problem of giving estimates for the exponents to problems concerning elementary properties of binomial coefficients. This is in lieu of the very complicated existence and precedence conditions found in Hall's work.

GAGLIONE, Anthony M., Associate Professor, "The Persistence of Universal Formulas in Free Algebras," *Bulletin of the Australian Mathematical Society*, 36 (1987), 11-17.

Let γ be any non-trivial variety of algebras of some fixed but arbitrary similarity type. Here non-trivial means the variety must contain at least one algebra with at least two elements. This paper gives necessary and sufficient conditions for the free algebras of γ to satisfy the same universal sentences in an appropriate language. The conditions are the discrimination of γ by its free algebras in the sense of Baumslag, Neumann, Neumann, and Neumann (B+3N). The paper also gives necessary and sufficient conditions for the free algebras of γ to satisfy the same universal formulas. These conditions are the *strong discrimination* of γ by its free algebras. Although on the surface it may seem that strong discrimination is a stronger concept than (B+3N) discrimination, this paper constructs several examples where these concepts are equivalent. It is an open question whether or not, in an arbitrary variety, (B+3N) discrimination implies strong discrimination.

GAGLIONE, Anthony M., Associate Professor, co-author, "Factor Groups of the Lower Central Series of Free Products of Finitely Generated Abelian Groups," *Proceedings of Group - St. Andrews 1985, London Mathematical Society Lecture Notes*, 2 (1987), 164-203.

This paper elaborates upon and extends previous work of the authors concerning the groups G_m/G_{m+1} where G is a free product of finitely generated Abelian groups and G_m denotes the n th term of the lower central series of G .

GOTAY, Mark J., Assistant Professor, "Negative Energy States in Quantum Gravity?" *Classical and Quantum Gravity*, 3 (1986), 487-491.

The mechanism of quantum tunneling through classical constraints is analyzed from the standpoint of geometric quantization theory. It is shown that quantizations which lead to this phenomena are spurious and a quantization ansatz is proposed which eliminates such pathologies. It follows that this mechanism does not provide a physically viable means of transcending the classical positive energy theorems in quantum gravity.

GOTAY, Mark J., Assistant Professor, co-author, "Singular Angular Momentum Maps," *Journal of Differential Geometry*, 24 (1986), 181-203.

The investigators algebraically reduce the system consisting of a nonrelativistic particle moving in R^n with vanishing angular momentum L . After analyzing the conical structure of the constraint set $L^{-1}(0)$, algebraic geometric methods are used to construct explicitly the reduced Poisson algebra of rotationally invariant observables. This procedure enables the investigators to identify completely the effects of the singularity in $L^{-1}(0)$ on the system. The system is then group-theoretically reduced, and the results are compared with those obtained algebraically.

GOTAY, Mark J., Assistant Professor, "Constraints, Reduction and Quantization," *Journal of Mathematical Physics*, 27 (1986), 2051-2066.

Theorems are proven that establish the unitary equivalence under certain conditions of the extended and reduced phase space quantizations of a constrained classical system with symmetry. Several examples are presented.

GOTAY, Mark J., Assistant Professor, "A Class of Non-polarizable Symplectic Manifolds," *Monashefte Für Mathematik*, 103 (1987), 27-30.

A class of compact 4-dimensional symplectic manifolds which admit no polarizations whatsoever is presented. These spaces also provide examples of non-parallelizable symplectic manifolds which have no complex, and hence no Kahler structures.

HERRMANN, Robert A., Associate Professor, "D-world Evidence," *CRS-Quarterly*, 23, 2 (1986), 47-54.

This article discusses indirect evidence for the acceptance of the deductive-world model. This evidence includes the unification of certain incompatible logics internal to quantum mechanics, other physical theories, and computer science; subparticle models for quantum transitions; the formation of elementary particles and fields; the local special theory of relativity; and how such subparticle models with hyperfast subparticles explain the experimental results associated with the Bell inequality.

KAPLAN, Harold M., Professor, "A Method of One-sided Nonparametric Inference for the Mean of a Nonnegative Population," *American Statistician* (May 1987), 157-158.

For a few values drawn independently at random from a nonnegative population, the investigator presents what he has found to be an effective nonparametric method of one-sided inference for the population mean. The method is based on a Martingale argument and use of the Markov inequality.

KIDWELL, Mark E., Associate Professor, "On the Two-variable Conway Potential Function," *Proceedings of the American Mathematical Society*, 98 (November 1986), 485-494.

The Conway potential function $\nabla(r,s)$ of a link with one unknotted component labeled s and all other components labeled r can be computed recursively using the first two Conway identities. $\nabla(r,s)$ can be written uniquely as a polynomial in $z_1=r-r^{-1}$, $z_2=s-s^{-1}$, and the first power of $z_{12}=rs+r^{-1}s^{-1}$.

MALEK-MADANI, Reza, Associate Professor, "Waves in Nonlinearly Viscoelastic Media," *Contemporary Mathematics*, 60 (1987), 1-10.

This paper presents an existence and uniqueness theorem for shearing motions in incompressible nonlinearity viscoelastic media. Travelling wave solutions are constructed. The qualitative behavior of solutions depends on the constitutive equations, and the entropy conditions for the limiting hyperbolic system depend on the way the constitutive equations allow the vanishing of viscosity.

MALEK-MADANI, Reza, Associate Professor, "Regularity of Local Minimizers of an Isotropic Compressible Hyperelastic Material," *Journal of Applied Analysis*, 22 (1986), 55-70.

The regularity of local minimizers and almost local minimizers are considered for the functional

$$E(u) = \int_{\Omega} \left[\text{tr}(\nabla u \cdot \nabla u^T) + a[\det \nabla u]^{1/3} \right] dx$$

where $u: \Omega \rightarrow R^3$, Ω is bounded and open.

$$u = \begin{pmatrix} u_1 \\ u_2 \\ u_3 \end{pmatrix} \quad \text{Fix } u_3 \text{ is given,}$$

and a is arbitrary scalar. The following theorem is proved: Let $u \in W^{1,2}(\Omega; R^3)$ be a local minimizer or almost minimizer of E . Then u is everywhere

(Holder) continuous in Ω . In particular, this theorem shows that cavitation does not occur in a solid material where the nonlinearity $[\det \nabla u]^{1/3}$ is dominated by the quadratic term $\text{tr}(\nabla u \cdot \nabla u^T)$.

MALEK-MADANI, Reza, Associate Professor, "Dissipative Mechanisms," *JMA Volumes in Mathematics and its Applications*, 3 (1987) 1-16.

Shearing motions of a viscoelastic medium are studied. Very general viscosity mechanisms are introduced and their influence on the shock structure of the elastic media are explained.

MOEN, Courtney H., Assistant Professor, "The Dual Reductive Pair $(U(3), U(1))$ over a p -adic Field," *Pacific Journal of Mathematics*, 127, 1 (March 1987), 141-154.

This paper considers some aspects of the oscillator representation of the dual reductive pair $(U(3), U(1))$ over a p -adic field, with $p \neq 2$. Howe's general construction [Ho] is specialized to this case and some necessary results from an earlier paper by this researcher concerning the dual pair $(U(1), U(1))$ are reviewed. The irreducible constituents of the oscillator representation restricted to $U(3)$ are then considered. First the constituents which embed in principal series are determined, and some explicit information concerning these embeddings are found. The researcher next shows that each irreducible supercuspidal constituent is induced from a representation of a maximal compact subgroup of $U(3)$. A surprising feature is that in all cases except that in which $U(3)$ is defined over an unramified extension and representations of conductor one are being considered, the group over the ring of integers does not suffice, and the other class of maximal compact subgroups must be used.

RICHTER, R. Bruce, Assistant Professor, "Contractions and Crossing Numbers," *Notes from Graph Theory Dav IX*, New York Academy of Sciences (1985), 23-24.

The crossing number $vc(G)$ of a graph G is the minimum number of pairs of crossing edges among all drawings of G in the plane. Thus $vc(G)=0$ if and only if G is planar. If e is an edge in the graph G , $G-e$ is the graph with edge e deleted. It is obvious that $vc(G-e) \leq vc(G)$. Let $G \cdot e$ denote the graph with the endpoints of e identified and e deleted. An example is given to show that $vc(G \cdot e) > vc(G)$ is possible.

RICHTER, R. Bruce, Assistant Professor, co-author, "Circuits in 4-regular plane graphs," *Congressus Numerantium*, 53 (1986), 36-47.

A plane graph is a graph embedded in the plane. A straight-ahead walk in a 4-regular plane graph is a walk that leaves each internal vertex v of the walk along the edge opposite to the edge upon which the walk enters v . A $*$ -circuit is a circuit that is also a straight-ahead walk. Thus the origin of a $*$ -circuit is distinguished.

Let X_n denote the class of 4-regular plane graphs having n vertices and a straight-ahead Euler tour. Set $C_n = \{k \mid \text{some } G \in X_n \text{ has exactly } k \text{ } * \text{-circuits}\}$. In this work, C_n is completely determined:

$$C_n = \{k \mid 2 \leq k < n\} \text{ } n \text{ even,}$$

$$C_n = \{k \mid 2 \leq k \leq n\} \cup \{k \mid n < k \leq 2n, k \text{ even, } k \neq 2n-2\} \text{ } n \text{ odd.}$$

RICHTER, R. Bruce, Assistant Professor, co-author, "Conprimal Graphs," *Congressus Numerantium*, 53 (1986), 87-94.

A graph G is said to be decomposed into subgraphs H_1, H_2, \dots, H_n if every edge of G lies in exactly one H_i . Let T_c be any set of connected graphs and S_c be any subset of T_c . S_c is said to be conprimal relative to T_c if each graph in T_c decomposes into distinct elements of S_c and no graph in S_c can be decomposed into other elements of S_c .

The main theorem states that for any set of connected graphs T_c , a unique subset S_c of T_c exists which is conprimal relative to T_c .

If T_c is the set of all connected graphs, several families of graphs are shown to be conprimal. A complete determination of S_c for this T_c is still open.

WARDLAW, William P., Associate Professor, "Advanced Problem 6528," *The American Mathematical Monthly*, 93:8 (October 1986), 659.

The following is problem 11 on page 44 of C. Chevalley's *Fundamental Concepts of Algebra*. Academic Press (1956):

Let H be a subgroup of a group G . Show that the elements s of G such that the mapping $t \rightarrow sts^{-1}$ of G into itself map H into itself form a subgroup N of G , of which H is a normal subgroup; show that every subgroup of G containing H and in which H is normal is contained in N . Provide an example to show that the assertion of the problem is false.

WARDLAW, William P., Associate Professor, "Solution to problem 1221," *Mathematics Magazine*, 59:4 (October 1986), 240-241.

This solution to problem 1221 previously posed in this journal by William A. McWorter, Jr., shows that if k and n are fixed integers with $1 < k < n$, then the subgroup of the symmetric group S_n generated by the k -cycles $(x, x+1, \dots, x+k-1)$ for $x=1, 2, \dots, n-k+1$ is the whole symmetric group S_n when k is even, and the alternating group A_n when k is odd.

WARDLAW, William P., Associate Professor, "Solution to problem 297," *The College Mathematics Journal*, 18:1 (January 1987), 72.

This solution to the previously posed problem 297 of M. S. Klamkin shows that if $H_i(x_1, x_2, \dots, x_r)$ is homogeneous of degree n_i , for $i=0, 1, \dots, s$, and $H_0 = F(H_1, H_2, \dots, H_s)$, then H_0 is homogeneous in the functions J_1, J_2, \dots, J_s , where

$$J_i = H_i^{1/n_i}$$

WARDLAW, William P., Associate Professor, "Solution to problem 299," *The College Mathematics Journal*, 18:1 (January 1987), 74-76.

This solution to problem 299 posed by Arnold Lapidus uses methods of probability and game theory to solve the following game: Peter and Paul are to simultaneously choose one triplet apiece from among HHH, HHT, HTH, HTT, THH, THT, TTH, TTT. A fair coin is used to produce an indefinitely long sequence of H's or T's until either Peter's or Paul's triplet appears. The player whose triplet occurs first wins one unit from the other. Peter wishes to win as much as possible. What is his optimal strategy? The solution is that Peter should select a

number u satisfying $2/5 \leq u \leq 3/5$, and then randomly choose HTT with probability u and THH with probability $1-u$.

WARDLAW, William P., Associate Professor, "Common solution to problem 300," *The College Mathematics Journal*, 18:1 (January 1987), 76.

This common solution independently submitted by four solvers to problem 300, previously posed by K. R. S. Sastry of Addis Ababa, Ethiopia, shows that if AD is the bisector of $\angle BAC$ of a triangle ABC , then $AD = AC \cdot AB / BC$ if and only if angle A is twice one of the other angles of the triangle.



Presentations

BAILEY, Craig K., Assistant Professor, "**A Combinatorial Inequality**," Washington and Lee Mathematics Colloquium, Lexington, Virginia, 14 October 1986.

BAILEY, Craig K., Assistant Professor, "**Using the Binomial Theorem in Combinatorial Inequalities**," Mathematical Association of America Sectional Meeting, Rockville, Maryland, 6 November 1986.

BAILEY, Craig K., Assistant Professor, "**Dissection of Equilateral Triangles**," Seventeenth Annual Southeastern Conference on Combinatorics, Graph Theory, and Computing, Boca Raton, Florida, 24 February 1987.

COOK, Christopher M., and Eric C. RUTTENBURG, Midshipmen 2 C, "**Lanchester's Square Law in Discrete Variables**," MD-VA-DC Sectional Meeting of the Mathematical Association of America, Loyola College, Baltimore, Maryland, 22 November 1987.

CRAWFORD, Carol G., Associate Professor, "**First China USA Graph Theory Conference**," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 29 October 1986.

CRAWFORD, Carol G., Associate Professor, "**Trends in Research Papers for *The American Mathematical Monthly***," Editorial Board Meeting, San Antonio, Texas, 21 January 1987.

GOTAY, Mark J., Assistant Professor, "**Momentum Mappings and Constraints in Relativistic Field Theory**," Eleventh International Conference on General Relativity and Gravitation, Stockholm, Sweden, 6-12 July 1986.

GOTAY, Mark J., Assistant Professor, "**Some Recent Results in Symplectic Geometry**," Special Year in Geometry, University of Illinois, Champaign-Urbana, Illinois, 16-20 November 1986.

GOTAY, Mark J., Assistant Professor, "**The Quantization of Constrained Systems with Symmetry**," Special Year in Geometry, University of Illinois, Champaign-Urbana, Illinois, 16-20 November 1986.

GOTAY, Mark J., Assistant Professor, "**Quantum Gravitational Collapse**," Invited Lecture to the Special Year in Geometry, University of Illinois, Champaign-Urbana, Illinois, 16-20 November 1986.

GOTAY, Mark J., Assistant Professor, "**The Relation between Gauge Symmetries and Constraints in Relativistic Field Theory**," University of Minnesota, Minneapolis, Minnesota, 25-28 February 1987.

GOTAY, Mark J., Assistant Professor, "**Four Dimensional Symplectic Geometry**," University of Minnesota, Minneapolis, Minnesota, 25-28 February 1987.

GOTAY, Mark J., Assistant Professor, "**A Class of Non-polarizable Symplectic Manifolds**," Lehigh University Geometry and Topology Conference, Bethlehem, Pennsylvania, 20-23 May 1987.

HERRMANN, Robert A., Associate Professor, "**Physics is Legislated by a Cosmogony**," Mathematical Association of America Regional Meeting, Loyola College, Baltimore, Maryland, 22 November 1986.

HERRMANN, Robert A., Associate Professor, "**Modern Cosmogony Research**," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 9 April 1987.

HERRMANN, Robert A., Associate Professor, "**The Metamorphic Universe**," Essex Community College Conference, Essex Community College, Baltimore, Maryland, 4 June 1987.

HOFFMAN, Michael E., Assistant Professor, "**Folding Polynomials**," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 15 October 1986.

HOFFMAN, Michael E., Assistant Professor, "**Generalized Chebyshev Polynomials Associated with Affine Weyl Groups**," University of Maryland Geometry Topology Seminar, College Park, Maryland, 15 December 1986.

HOFFMAN, Michael E., Assistant Professor, "Non-coincidence Index of Manifolds," Lehigh University Geometry and Topology Conference, Bethlehem, Pennsylvania, 23 May 1987.

KAPLAN, Harold M., Professor, "Small Alphas are Better Than They Look," Probability-Statistics Day, University of Maryland Baltimore County, Baltimore, Maryland, 6 December 1986.

KAPLAN, Harold M., Professor, "Few Blocks and Any Number of Treatments for Non-Negatives," Probability and Statistics Day, University of Delaware, Newark, Delaware, 9 May 1987.

KIDWELL, Mark E., Associate Professor, "Polynomial Invariants of Two-Label Links," Braids Conference, University of California at Santa Cruz, Santa Cruz, California, 15 July 1986.

KIDWELL, Mark E., Associate Professor, "Knot Polynomials," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 15 October 1986.

MARUSZEWSKI, Richard E., Captain, USNR, "Horse: A Probabilistic Look at a Game of Chance," Annual Conference of New York State Mathematics Teachers, Syracuse, New York, 25 April 1987.

MASSELL, Paul B., Assistant Professor, "Dynamical Systems and Probability," Salisbury State College, Salisbury, Maryland, 30 April 1987.

MASSELL, Paul B., Assistant Professor, "A Survey Course on Dynamical Systems," Chapter Spring Meeting, Mathematical Association of America, Salisbury State College, Salisbury, Maryland, 30 April 1987.

MCCOY, Peter A., Professor, "Representation of Harmonic Functions on the Group $SU(2)$," Ninety-third Annual Meeting of the American Mathematical Society, San Antonio, Texas, 21 January 1987.

MOEN, Courtney H., Assistant Professor, "Gauss Sums and Metaplectic Groups," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 10 December 1986.

MOEN, Courtney H., Assistant Professor, "Gauss Sums and Metaplectic Groups II," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 15 April 1987.

MOEN, Courtney H., Assistant Professor, "E-Factors for Covering Groups of $GL(2)$," American Mathematical Society Meeting, Newark, New Jersey, 26 April 1987.

MYLANDER, W. Charles, Professor, "Building & Solving LP Models on a PC," Maryland Chapter Operations Research Society of America Institute of Management Science, Baltimore, Maryland, 8 December 1986.

PARSONS, Lee, Commander, USNR, "A Game Called Horse," New York State Mathematics Association of Two Year Colleges Annual Conference, Syracuse, New York, 25 April 1987.

PENN, Howard L., Associate Professor, "The Use of Computer Graphics in the Teaching of Differential Equations," Joint National Meeting of the American Mathematical Society and the Mathematical Association of America, San Antonio, Texas, 23 January 1987.

PENN, Howard L., Associate Professor, "The Kodak Datashow Projector," U.S. Naval Academy Mathematics Department Seminar on Computer Usage, Annapolis, Maryland, 2 February 1987.

PENN, Howard L., Associate Professor, "How Computers Can Enhance the Teaching of Calculus," Mathematical Association of America Sectional Meeting, Salisbury, Maryland, 13 June 1987.

PRICE, Geoffrey L., Assistant Professor, "Shifts on the Hyperfinite II₁ factor," Functional Analysis Seminar, University of Iowa, Iowa City, Iowa, 6 March 1987.

WARDLAW, William P., Associate Professor and R. Bruce RICHTER, Assistant Professor, "Diagonalization over Commutative Rings," Ninety-third Annual Meeting of the American Mathematical Society, San Antonio, Texas, 23 January 1987.

WITHERS, William D., Assistant Professor, "**Folding Polynomials and Their Dynamics**," University of Maryland Summer Dynamics Seminar, College Park, Maryland, 1 July 1986.

WITHERS, William D., Assistant Professor, "**Iterated Function Systems**," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 11 February 1987.

WITHERS, William D., Assistant Professor, "**Newton's Method for Fractal Approximation**," Department of Mathematics, Georgia Institute of Technology, Atlanta, Georgia, 5 March 1987.

WITHERS, William D., Assistant Professor, "**Folding Polynomials**," Department of Mathematics, Japanese National Defense Academy, Yokosuka, Japan, 13 May 1987.

WOLFE, Carvel S., Associate Professor, "**Multiplex or a Combination Simplex-Dual-Simplex Method for L.P.**," Mathematics Colloquium, U.S. Naval Academy, Annapolis, Maryland, 23 September 1986.





Oceanography

COMMANDER MICHAEL P. CAVANAUGH, USN
CHAIRMAN

During the 1986-1987 Academic Year, civilian faculty members conducted sponsored research in a broad range of oceanographic and atmospheric areas. This research provided opportunities for the faculty to keep abreast of current work, and it served as the basis for qualified midshipmen to undertake related research projects.

Funding was secured from the Defense Mapping Agency, the Johns Hopkins University-Applied Physics Laboratory, the National Science Foundation, the Office of Naval Research and the Commander, Naval Oceanography Command.

Specific areas of research activity within the Department included, but were not limited to, sound propagation, light attenuation, turbidity, mathematical modeling of the Severn River, shelf break upwelling, arctic ocean current reversals, chemical composition of snowfalls, and sun glint pattern analysis.



Sponsored Research

Turbidity in the Chesapeake Bay

RESEARCHER: PROFESSOR JOHN W. FOERSTER
SPONSOR: DEFENSE MAPPING AGENCY

Studies on sediment particles, turbidity, and the attenuation coefficient continue. Analyses of 8 years of data is beginning.

Predictive Model of Severn River Ecosystem

RESEARCHER: PROFESSOR JOHN W. FOERSTER
SPONSOR: DEFENSE MAPPING AGENCY

Development of a mathematical model for the ecosystem of the Severn River is underway. Baseline data collections are in analysis presently.

Shelf Break Upwelling in the Denmark Strait

RESEARCH: PROFESSOR JOHN W. FOERSTER
SPONSOR: DEFENSE MAPPING AGENCY

Investigations of historical oceanographic records and recent infrared satellite scans in the area between longitude 24° west to 32° west and latitude 62° north to 66° north have led to the discovery of a zone of apparent unstable water. This zone is located between the 200-m and 1,000-m bathymetric contours west of Iceland in the Denmark Strait. The study area was and is very active in biological production. It has provided the majority of the catch for the Icelandic whale fishery. A survey expedition investigated this area in June of 1981. Calculations from the survey data revealed that water was transporting to the Northwest at $2.3 \times 10^6 \text{ m}^3 \text{ sec}$

with an average Ekman layer depth of 74 m. An anomaly in the vertical Sigma-t distribution indicated water movement towards the surface. This physical information, results of water chemistry for ortho phosphate, distribution of the biota and the infrared satellite scans have led to the conclusion that upwelling conditions exist during the polar summer in this area of the Denmark Strait. This upwelling is believed to be a function of the particular air-sea interaction conditions that exist at this time of year. The result of this interaction has been the development of a 34,000 km² area of high biological productivity.

Geostrophic Wind Velocity Thresholds for Bering Strait Current Reversals Under Open Water and Ice-Covered Conditions

RESEARCHER: VISITING PROFESSOR THOMAS L. KOZO
SPONSOR: OFFICE OF NAVAL RESEARCH

The weather stations at Uelen (Siberia), Bukhta Provideniya (Siberia), and Nome (Alaska) surround the Bering Strait. Surface atmospheric data simultaneously transmitted from this network can be used to calculate a geostrophic wind velocity (V_g) for the Strait center. Strait currents 10–20 m off the bottom have been extracted from two data sets, one for September 1976–March 1977 (Coachman and Aagaard, 1981) and another for November 1981–April 1982 (Aagaard et al., 1985). Historical V_g data and the above current data have been matched to develop prediction nomograms for flow reversals and refinement of transport estimates.

The data were also examined to determine ice cover effects on current reversal thresholds. Satellite data showed that total ice cover existed by 21 November in each study year.

Results show that a V_g component from 40° (V_{40}) will reverse normal current flow from north to south at a magnitude of 8 ms^{-1} under open water conditions. During ice cover, however, a V_{40} of at least 12.5 ms^{-1} is needed to reverse the current from north to south, which is a 56% increase in magnitude.

A paper documenting this research has been submitted to the *Journal of Geophysical Research*.

Mesoscale Meteorology of the Norton Sound Region

RESEARCHER: VISITING PROFESSOR THOMAS L. KOZO
SPONSOR: OFFICE OF NAVAL RESEARCH

An analysis of 1964–1968 surface winds, pressures, and temperatures at three weather stations surrounding Norton Sound was performed. The stations in this former network were Northeast Cape (St. Lawrence Island, outside the Sound), Nome, and Unalakleet. Their surface pressure data were used to calculate geostrophic wind velocities at the Sound center for comparison with simultaneous coastal surface winds.

Mesoscale orographic effects at Nome and Unalakleet were most evident (20 percent of the data sets) in the winter months when the Sound was ice covered. Maximum cold air drainage winds recorded at Unalakleet were 16 ms^{-1} and 14.5 ms^{-1} at Nome. Ten percent of all wind velocities recorded at Nome for January and February were zero, due to orographic blockage and corner effects. Wind steadiness at all sites reached a maximum during this same season.

Mesoscale thermal effects were seen as sea breezes in the Sound during open water months. The highest sea breeze velocities reached were 10.8 ms^{-1} at both Nome and Unalakleet. Examination of rotary spectra from station wind velocity time series at Nome and Unalakleet showed an additional mountain-valley wind system caused by combined thermal and orographic effects. Therefore a pseudo summer land breeze can exist in coastal Arctic regions, producing offshore winds in areas with river valleys and small mountain ranges. The maximum offshore winds due to this effect were 11.3 ms^{-1} at Nome and 10.8 ms^{-1} at Unalakleet. The combined effects of July and August were dominant in more than 26 percent of the surface wind data.

Mountain Barrier Effects on Sea Ice Drift in the Beaufort Sea Coastal Ice Zone

RESEARCHER: VISITING PROFESSOR THOMAS L. KOZO
SPONSOR: OFFICE OF NAVAL RESEARCH

Three satellite transmitting surface weather stations were deployed in March 1982 on the sea ice 100 km north of Barter Island (ICE), the foothills of the Brooks Range (JAGO), and Narwhal Island, respectively. These formed a network providing data for calculation of high resolution geostrophic winds, near mountain pressure gradients, and net wind vector turning with height.

Near mountain pressure gradients, which were not recorded on National Weather Service (NWS) charts, opposed synoptic pressure gradients 36% of

the time from March through May 1982. These mesoscale pressure gradients, if large enough, caused 140° wind direction reversals as far as 110 km offshore at station ICE. The critical value for the extensive reversals averaged .08 mbk⁻¹ from Barter Island to JAGO. As late as May 1982 station ICE was still inside the influence zone of the Brooks Range. The sea ice was less consolidated than in the winter months, and two reversals in drift motion directly attributable to mountain barrier effects were seen.

Analysis of Glint Patterns Utilizing Remote Sensing Techniques

RESEARCHER: MIDSHIPMAN 1 C DEBORAH D. KLATT
ADVISERS: VISITING PROFESSOR ALAN E. STRONG,
LIEUTENANT COMMANDER JOHN GLEASON, USN, AND
MS. LOUISE WALLENDORF (HYDROMECHANICS LABORATORY)
SPONSOR: TRIDENT SCHOLAR PROGRAM

The researcher began by examining sunglint from features in the Navy Coastal Tank in an attempt to simulate structure and glint patterns observed by Shuttle astronauts and captured in their photographs of the Mediterranean Sea. The project concluded with the use of NOAA AVHRR satellite imagery in the infrared that were taken nearly coincidentally with the shuttle pictures to show that these features revealed in the glint regions are related

to surface current fields. It appears from the relationship of the thermal - IR features with the eddy patterns seen in the shuttle photos that expressions are present that tie directly with surface currents, not just surface film wind fields. These conclusions should help future researchers in this area continue to build upon this knowledge base, and with utilization of patterns in the glintlight area, aid in mesoscale surface current determinations.

Independent Research

LSAP

RESEARCHER: PROFESSOR DOUGLAS W. EDSALL

This is a classified ASW project concerned with ways to enhance Signal-to-Noise ratio for detection of shipping. The project required analysis of proposed oceanic test sites from a geological and geo-

physical viewpoint. Analysis was transmitted in the form of a written confidential report to the project sponsor.

Chemical Composition of Snowfalls and Snowpacks: Contribution of Rime Ice and Hoar Frost

RESEARCHER: VISITING PROFESSOR EDWARD E. HINDMAN

Aerosol particle scavenging by snow is poorly understood. Consequently, a study was conducted at Storm Peak Lab (3220m MSL) in the Colorado Rocky Mountains to investigate the fractionation of atmospheric aerosol particles among ice crystals (snow), cloud water, and cloud interstitial aerosol particles. The experiments were conducted when the laboratory was enveloped by a supercooled mixed-phase cloud base typically 300m below the laboratory. Snow, cloud water, and aerosol particles were collected and analysed for trace elements and soluble ions. The cloud water and snow were also analysed for pH and conductivity.

Results show most of the soluble species from the aerosol particles (ions, acidity, etc.) are present in the supercooled liquid water. Snow which grows at the expense of cloud droplets (depositional growth) has low concentrations of contaminants. These results indicate that when the snow crystal riming mechanism dominates snow crystal growth, it controls the chemical composition of the snow. Preliminary evidence indicates a variation in chemical composition as a function of cloud droplet size.

This research was conducted in connection with Colorado State University and sponsored by the National Science Foundation.



Research Course Projects

Automated Weather Station Drift in the Alaskan Beaufort Sea Coastal Ice Zone

RESEARCHER: MIDSHIPMEN 2 C PATRICIA A. LIPOMA

ADVISER: VISITING PROFESSOR THOMAS L. KOZO

In the coastal ice zone, sea ice motion was determined by movement of an automated satellite transmitting weather station (System ARGOS) placed north of Barter Island on the pack ice in March 1982. This station collected wind vectors, pressure, temperature, position, and magnetic compass heading data until the middle of July. Two other land stations, one at the foothills of Brooks Range and the other on Narwhal Island, formed a mesoscale atmospheric pressure network when combined with the drifting station. This network was used to enhance prediction of station drift over that provided by synoptic wind analysis.

In the months of March and April when the

pack was consolidated, a maximum daily station movement of 8.9 km was seen for 12.5 m s⁻¹ easterly winds. During May and June when the ice pack became less consolidated, there was evidence of free drift. Maximum daily station movement after this date was 55 km for easterly winds of 12.5 m s⁻¹. May data showed two 9 km reversals in the ice floe movement (from west to east) at about 120 km from the coast. The Brooks Range mountain barrier effect has been shown to be the cause. After 31 May, as distance from the Brooks Range increased, there was no evidence that mountain barrier effects altered ice floe motion in the station vicinity.



Publications

FOERSTER, John W., Jerome WILLIAMS, Professors, and Frederick A. SKOVE, Associate Professor (Computer Science), "Diurnal Variation of Surface Phytoplankton in the Denmark Strait," *Estuarine Variability*, ed. D. Wolte, New York: Academic Press, 1980, pp. 193-202.

Data were taken at two-hour intervals over a 24-hour period at a station near the mouth of the Patuxent River, a sub-estuary of the Chesapeake Bay. This station was occupied on 13-14 July 1983, and the sequence was repeated on 25-26 June 1984, with similar results. Measurements of surface beam transmittance indicated a diurnal variation with a minimum occurring at about 1800 and a maximum after midnight. The late afternoon transmittance was about half that during nighttime. Optical measurements were correlated with concentration of suspended particles, and changes in the size distribution of the suspended material were associated with changes in transparency. Through the use of optical measurements, particle counts, chlorophyll *a* measurements, and phytoplankton analyses, the researchers determined that phytoplankton populations are probably changing by at least an order of magnitude over each diurnal cycle. Examination of tidal movement and the entire water column led to the conclusion that these daily variations were due to grazing, and were not associated with horizontal advection or sinking. A mathematical model using a bimodal grazing pattern, coupled with an exponential solar-controlled growth rate, fitted the data reasonably well.

HINDMAN, Edward E., Visiting Professor, "Characteristics of Supercooled Liquid Water in Clouds at Mountaintop Sites in the Colorado Rockies," *Journal of Climate and Applied Meteorology*, 9 (September 1986), 1271-1279.

Observations and measurements were made of supercooled liquid water in clouds which enveloped high elevation sites in the Colorado Rocky Mountains for the winters of 1980-81 through 1983-84. The observations showed that liquid water was more frequent at the southern and northern Rocky sites than at the central sites. Eighty percent of the liquid water periods persisted 3 to 20 h at the northern Rocky site. This site was enveloped by supercooled liquid cloud 24% of the time during the months of December 1981 and January 1982. Average liquid water contents at the sites ranged between 0.14 to 0.23 g m⁻³; the maximum individual value was 0.60 g m⁻³. The measurements indicated that substantial amounts of liquid water were flowing over the Colorado Rockies at mountaintop heights.

HINDMAN, Edward E., Visiting Professor, co-author, "The Relationship Between Marine Aerosol Particles and Satellite-detected Radiance," *Journal of Geophysical Research*, D3 (March 1986), 4063-4072.

An experiment is described which investigated the relationship between marine aerosol particles and satellite-detected radiance. The experiment resulted in a near-simultaneous set of visible and near-infrared satellite images and aircraft aerosol particle and state variable measurements. These data demonstrated that satellite-detected radiance at red-visible and near-infrared wavelengths is positively correlated with aerosol optical depth. Further, the data show that relative humidity changes account for variations in aerosol particle size, which in turn lead to variations in satellite-detected upwelling radiance. Therefore, it appears possible to use satellite imagery to investigate variations of marine boundary layer aerosol particles and relative humidity.

HINDMAN, Edward E., Visiting Professor, "Physical and Optical Properties of a Laboratory Cloud," Preprints of Conference on Cloud Physics, American Meteorological Society, Boston, Massachusetts, (September 1986), JP7-JP10.

Droplet spectra measurements from a slow-expansion cloud chamber experiment were analyzed for their physical and optical properties. The vertical distribution of liquid water content, average droplet sizes and b-scat values just above and below "cloud base" were in remarkable agreement with Noonkester's measurements beneath and within marine stratus. The LWC value assumed by Noonkester of 0.02 g m^{-3} to define cloud base was confirmed by the chamber results. The chamber droplet spectra dispersion values decreased with increasing distance above "cloud base," demonstrating a narrowing of the droplet spectra due to condensation growth of the droplets. This narrowing appears to be slower than that predicted by theory. Finally, a minimum visual range of 4m was achieved at the termination of the chamber expansion. This value is sufficiently low to conclude that electromagnetic energy propagation experiments appear feasible within the cloud chamber.

KOZO, Thomas L., Visiting Professor, co-author, "Nowcasting Sea Ice Movement Through the Bering Strait," *Proceedings of the Fifth International Offshore Mechanics and Arctic Engineering Symposium*, 4 (1986), 394-402.

Geostrophic wind velocities were calculated using atmospheric pressure data from Bering Strait stations at Uelen (Siberia), Bukhta Provideniya (Siberia), and Nome (Alaska). These velocities were matched to Strait sea ice displacements derived from satellite imagery (1974-1984), resulting in an all-weather ice movement nowcasting model. Also, five ice displacement modes were identified.

The first mode is Chukchi-to-Bering Sea movement when northeasterly winds exceed 11.5 m/s . The second and third modes are Bering-to-Chukchi Sea movement. Mode two is driven by a preexisting north-flowing ocean current during weak opposing winds. Mode three is due to winds and currents acting in concert.

The first immobilization mode (maximum duration one week) is an apparent balance between northerly wind stress, water stress from the south, and internal ice stresses. The second immobilization mode is due to large, double, solid ice arches jamming the Strait for up to four weeks.

KOZO, Thomas L., Visiting Professor, co-author, "Modeling Winds and Open-Water Buoy Drift Along the Eastern Beaufort Sea Coast, Including the Effects of the Brooks Range," *Journal of Geophysical Research*, 91, C11 (November 15, 1986) 13,011-13,032.

The United States Coast Guard deployed a cluster of satellite transmitting, surface-drifting buoys in the Beaufort Sea north of Prudhoe Bay, Alaska, on 17 August 1983. The surface currents in this coastal area are predominantly wind driven. An unusual stand of westerly winds led to eastward drift, with the surviving buoys moving into Mackenzie Bay (Canada) by mid-September. The buoy motion suggested that they were driven by the geostrophic wind modified by the orographic "umbrella" of the Brooks Range. This mesoscale effect can create changes in wind direction and regions of super- and sub-geostrophic speeds. It influenced an arcuate zone at least 50 km seaward of the coast from Camden Bay (Alaska) to Mackenzie Bay. A simple model was developed to predict the wind modifications and resultant wind-driven buoy drift. The model's initial wind velocity input is calculated geostrophic wind derived from triangular-shaped mesoscale atmospheric pressure network data. These networks were chosen because their boundaries alternately contained the trajectories of the eastward-moving buoys. The model then used this network velocity to generate an orographically-modified wind field at buoy locations in offshore areas north of the Brooks Range. The actual buoy drift during the open-water season covered approximately 650 km in 60 days, with the final model-predicted buoy drift position in error by less than 50 km. The Brooks Range influence did not appear to affect the October buoy drift, which was north of Richards Island (Canada) above 70°N and east of 135°N .

KOZO, Thomas L., Visiting Professor, co-author, "Mesoscale Nowcasting of Sea Ice Movement through the Bering Strait with a Description of Major Driving Forces," *Monthly Weather Review*, 115, 1 (January 1987), 193-207.

Surface atmospheric pressure data from a triangular station network surrounding the Bering Strait are used to calculate hypothetical geostrophic wind velocities. Net daily Strait sea ice movement is derived from visible and infrared NOAA satellite imagery for November through May 1974. These historical ice-motion data and network wind velocity data are used to develop an empirical 12-h advance forecast (nowcast) sea ice movement model with all-weather capabilities. A necessary outgrowth of this study has been the identification and classification of three modes of ice movement and two modes of ice immobilization according to their major driving forces. The first ice-movement mode is from the Chukchi to the Bering Sea, requiring a minimum northeasterly geostrophic wind of 12 m s^{-1} . The second and third modes represent ice movement from the Bering to the Chukchi Sea. Mode 2 is driven by a preexisting north-flowing ocean current that offsets weak winds from the northeast. Mode three is large movement due to a combination of southwesterly winds and north-flowing ocean current. The first immobilization mode (maximum duration one week) is an apparent balance between northerly wind stress, current stress from the south, and internal ice stresses. The second immobilization mode (least common) is due to double, solid sea ice arches forming across the Strait. These arches remained intact under strong northeasterly geostrophic winds ($20\text{--}26 \text{ m s}^{-1}$) and can last up to four weeks.

STRONG, Alan E., Visiting Professor, "The Effect of El Chichón on the 82-83 El Niño," *Proceedings of American Geophysical Union Meeting*, San Francisco, California, 8-12 December 1986, *EOS*, 67, p. 880.

Using updated volcanic aerosol information for the last 110 years, together with seasonally adjusted sea surface temperature anomalies, a strong relation is demonstrated between tropical eruptions, when stratospheric easterlies trap injected aerosols in zonal belts over the tropics for several months, and increasing sea surface temperatures (sst) of the eastern equatorial Pacific. A pronounced effect is shown to last for up to eighteen months when below normal SSTs were in effect at the time of the eruption. Along the equator this SST increase averages approximately $+0.75^\circ \text{C}$, as contrasted with no resulting increase during inactive volcanic years. Although the study reveals a relationship between eruption and subsequent SST increase, it does not prove "cause and effect" in the form of a volcanic triggering mechanism for El Niño, but rather a modifier to those oceanic/atmospheric processes already underway. The eruption of El Chichón in 1982 and the ensuing El Niño illustrates this relationship. Although signs of an El Niño were already evident before the eruption, El Chichón appears to have been responsible for dramatically amplifying the ocean warming that followed. More extensive and more rigorously determined measurements over the next 25 years of both volcanic aerosols and SSTs from satellite should more accurately define this important climatic relationship.

Presentations

HINDMAN, Edward E., Visiting Professor, "Ascending Mount Everest Through Soaring Flight," Atmospheric Science Department Seminar, Colorado State University, Fort Collins, Colorado, 1 August 1986.

HINDMAN, Edward E., Visiting Professor, "Physical and Optical Properties of a Laboratory Cloud," Oceanography Department Seminar, United States Naval Academy, Annapolis, Maryland, 18 September 1986.

HINDMAN, Edward E., Visiting Professor, "Physical and Optical Properties of a Laboratory Cloud," Conference on Cloud Physics, Snowmass, Colorado, 22-26 September 1986.

HOFFMAN, John F., Professor, "Teaching Oceanography to Potential Naval Officers," Annual Conference of the American Society for Engineering Education, Cincinnati, Ohio, 23 June 1986.

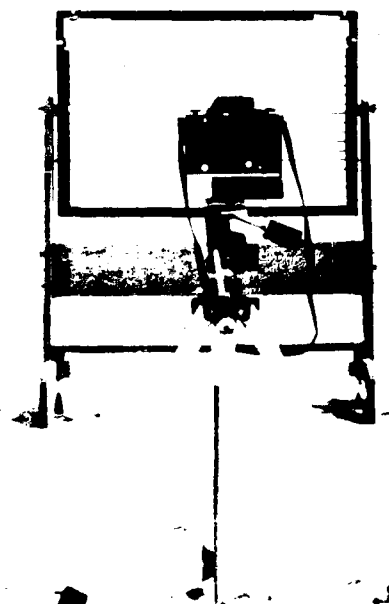
KOZO, Thomas L., Visiting Professor, "Nowcasting Sea Ice Movement and Ocean Current Reversals in

the Bering Strait," Workshop on Modeling Ocean and Sea Ice Transport in the Northern Bering and Chukchi Seas, Pacific Marine Environmental Laboratory, Seattle, Washington, 27-30 October 1986.

KOZO, Thomas L., Visiting Professor, "Geostrophic Wind Velocity Thresholds for Bering Strait Current Reversals under Open Water and Ice-Covered Conditions," American Geophysical Union Fall Meeting, San Francisco, California, 8-12 December 1986.

KOZO, Thomas L., Visiting Professor, "Mesoscale Meteorology of the Norton Sound Region," Ninth International Conference on Port and Ocean Engineering under Arctic Conditions, Fairbanks, Alaska, 17 August 1987.

LIPOMA, Patricia A., Midshipman Second Class, USN, "Automated Weather Station Drift in the Alaskan Beaufort Sea Coastal Ice Zone," Ninth International Conference on Port and Ocean Engineering under Arctic Conditions, Fairbanks, Alaska, 17 August 1987.



Physics

PROFESSOR GRAHAM D. GUTSCHE
CHAIRMAN

The Greek god Janus is depicted with two faces, one looking back to where he has been (the past) and the other looking forward to where he is going (the future). The study of physics in many ways manifests this Janus-like nature. As the basis for all physical science and engineering, it continually looks back at the foundational truths and concepts. At the same time, physics is at the forefront of the search to understand the nature of the universe, from the sub-atomic to the cosmic in dimension. The application of physics in today's Navy certainly reflects this duality. Many applications are clearly basic and foundational, while many others are at the cutting-edge of current technology. Naval Academy graduates must therefore have a solid command of the fundamentals, coupled with an openness to the new and experimental.

Ongoing research in physics is one of the means to this desired end. In addition it keeps the faculty involved and up-to-date in the practice of their profession. Through research project courses and the Trident Scholar program, it also affords midshipmen the opportunity to taste the joys and difficulties of the research endeavor. The current research in the Physics Department is broad based, including areas of non-linear acoustics, ship acoustic signatures, submarine magnetics, electromagnetic and galactic astronomy, solid state physics, polymer physics, nuclear physics, and computer technology. Many of these projects are applied research with direct naval application, while others are quite general, basic research.

In addition to departmental funds and Naval Academy Research Council grants, financial support for this year's research came from the Office



Naval Research, the Naval Research Laboratory, and the David W. Taylor Naval Ship Research and Development Center (both Annapolis and Carderock branches).

The increased availability and use of microcomputers in research has stimulated a continuing evolution of all of the physics course laboratories, where the micros are used both as laboratory instruments and as data analyzers. A significant amount of personal unfunded research in computer interfacing and software development is constantly in progress.

Sponsored Research

Multispectral Observations of FIRSSE Sources

RESEARCHER: ASSISTANT PROFESSOR C. ELISE ALBERT

SPONSOR: NAVAL RESEARCH LABORATORY

The purpose of this project is to identify and study objects detected by the Air Force Geophysics Laboratory Naval Research Laboratory Far Infrared Sky Survey Experiment, which scanned 21% of the sky in four infrared bands between 17 and 120 microns. Radio observations have been made of these sources with the Very Large Array of the National Radio Astronomy Observatory, and maps have been con-

structed at wavelengths of both 20cm and 6cm. An initial study has analyzed eight of these sources which are coincident with small optical ionized hydrogen regions.

The second phase of this project, which is scheduled to extend in 1987-88, includes analysis of the structure, temperature, and luminosity of several dozen additional sources HII regions.

High Pressure Differential Scanning Calorimetry of Ion-Conducting Polymers

RESEARCHER: LIEUTENANT DAVID A. BEAM, USN

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

There is currently much interest in the area of polymer solid electrolytes. These electrolytes exhibit a combination of the current-carrying abilities of aqueous electrolytes (e.g., the acid in a battery) and the physical properties of plastics (e.g., light weight, resistance to corrosion). Throughout the literature, there are widely varied assumptions concerning transport numbers, that is, which particular types of ion in the electrolyte are responsible for the transport of the electric charge resulting in an electric current, and what fraction of the total current is carried by each type of ion. It was initially assumed in much of the literature that only one type of ion in each electrolyte is responsible for the current. Presently, there is much debate concerning this assumption. This research will determine which ions

are moving and what fraction of the total current is carried by each type of ion. Direct current and alternating current techniques will be used in this determination. The results of this research should have great impact on the direction taken in future investigations and developments of solid electrolytes, and hold the potential for important application in the development of electrodes for a specific electrolyte, the structure of the electrode, and the interface between the electrode and the electrolyte.

An analysis of both electrical relaxation and conductivity data will be made using the Williams Watts Formulation. In order to do this it will be necessary to transfer the impedance data to electric modeling.

General Scattering of Acoustic Pulses

RESEARCHER: PROFESSOR DONALD W. BRILL

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

A search and study was made of the available literature on the scattering of acoustic pulses in general but most particularly by elastic objects. This is a preparation for the application of the Resonance Scattering Theory (RST), ultimately to the scattering of a pulse by an elastic object in a liquid. It is clear that the scattered pulse will contain a resonance structure which carries a description of the target's shape, size, and composition.

Such research begins with a study of the pulses

themselves, since there will be nothing present in the scattered pulse which was not present in the incident pulse. Next, the researcher studies the scattering from the simplest, most primitive objects such as spheres, cylinders, and eventually spheroids. This is done with hopes that when these primitive objects are present in some combination to form a more realistic target, that some of the resonance signatures of these simple shapes will remain with the more complex structure.

Transient Response to Stimulated Raman Scattering

RESEARCHER: PROFESSOR GERALD P. CALAME

SPONSOR: NAVAL RESEARCH LABORATORY

A set of programs has been written in order to study the transient response of a Raman Scattering Medium to a train of pump pulses passing through it, and used to study pulse trains over a wide range of steady-state gains and repetition rates. It was found that, whatever the gain and pulse length, a pulse repetition rate can be found that yields an amplified train of stokes pulses that propagates without exceeding the threshold conditions, the so-called "quasi

steady state" case. A semi-analytical approximation has been developed that reproduces the results of the purely numerical programs to within a few parts in a thousand, but does so in a very small fraction of the computer time.

The programs are now being generalized to allow detailed comparisons with experiments now in progress at the Naval Research Laboratory.



Ion Beam Mixing of Molybdenum in Aluminum

RESEARCHER: ASSOCIATE PROFESSOR FRANCIS D. CORRELL

SPONSOR: NAVAL RESEARCH LABORATORY

This study of ion beam mixing (IBM) of Mo in Al was part of an effort to improve the corrosion resistance of aluminum. Although it is a reactive metal, aluminum naturally forms a stable oxide film which protects it from corrosion on the large scale. This film occasionally breaks down in localized areas, however, leading to the formation and growth of deep corrosion pits. Ion implantation of Mo (and other elements) in Al has been found to inhibit this pitting corrosion, but the thickness of the protective layers that can be formed by conventional ion implantation is limited. Addition of Mo to Al by traditional alloying techniques is impractical because of the small solid solubility of Mo in Al. IBM is being examined as a means of preparing thick, corrosion-resistant surface alloys on Al.

Because IBM in the Mo-Al system has been studied very little, several basic questions must be answered before a practical technique can be developed. These include (1) the importance of a gradient in the damage introduced by the ion bombardment; (2) the temperature dependence of the mixing efficiency; and (3) the effects of grain size and the presence of interfacial oxygen on the apparent mobility of Mo in Al. The project represents some first steps toward answering these questions.

Modifications were made to an existing sample holder and target chamber to permit heating or cooling the samples and to improve electrical insulation and secondary electron suppression. Mixing of the Mo into the Al substrates was accomplished by bombarding with energetic Xe ions and was investigated using Rutherford backscattering spectrometry (RBS). Initial IBM studies were performed at room temperature using 1.8-MeV Xe ions, whose range in the samples is much greater than the depth of the Mo-Al interface, resulting in a fairly uniform damage concentration at the interface. These initial studies were done using two different kinds of samples: one consisting of a 30-nm-thick layer of vacuum-deposited Mo on Bulk Al, and the other consisting of a dual-energy (25 keV and 85 keV) implant of Mo⁺ ions in bulk Al. Mixing was observed in both kinds of samples, and the results are now being analyzed using the RBS analysis code RUMP. Further experiments will be done using 250keV Xe ions, which will produce a much steeper damage gradient at the Mo-Al interface, and additional sample designs will be explored.

Self-Sustained Oscillations Due to Orifices: Phase III: Interaction of Underwater Orifice Plates with Resonant Systems

RESEARCHER: PROFESSOR SAMUEL A. ELDER

SPONSOR: DAVID W. TAYLOR SHIP RESEARCH AND DEVELOPMENT CENTER,
CARDEROCK LABORATORY

This is part of a continuing project to investigate self-sustained oscillations due to underwater orifices, with application to the prediction, control, and elimination of orifice-connected tones in the design of ships. This includes tones generated by flow through orifices as well as over orifices. The present phase concerns pteiffenton and related phenomena, which have become important to the Navy in recent years on account of numerous tone generating situations associated with discharge through multi-hole plates, inboard piping, etc. The approach is to excite resonances of a large cavity by means of tone holes, supplied by a blowdown water tunnel. Measurements of flow patterns and acoustic radiation

are made in the field near the tone hole, using computer-controlled techniques, for Reynolds numbers up to about 100,000. Results of previous studies suggest that there are two regimes of interest: a laminar tone effect at Reynolds numbers below 5000, which is fairly well understood, and a turbulent tone effect that becomes important at Reynolds numbers above 50,000, and which remains to be accounted for. The aim of the present series of tests is to investigate the transition region between the two, with a view to illuminating some of the mechanisms involved in the high Reynolds number case. This phase is still in progress.

Stress Effects on Susceptibility of Grain-Oriented Silicon Steel

RESEARCHER: ASSISTANT PROFESSOR JOHN P. ERTL

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

Recent measurements show a reduction in the maximum susceptibility, χ_{max} , with increasing positive stress (stress in tension) in "semi-GOSS (Grain-Oriented Silicon Steel) material" as predicted by known models. A corresponding increase in χ_{max} is observed with increasing negative stress (stress in compression). The available material has been shown not to be "pure GOSS" thereby accounting for a somewhat lower value for χ_{max} . Carefully pre-

pared (stress relieved) samples of "pure GOSS" type material are to be prepared by baking the available material, and the above measurements will be repeated to see if the commonly accepted higher values of χ_{max} can be obtained. The variation in χ_{max} with stress in "semi-GOSS material" has been found to be sensibly independent of the frequency and shape of the applied coercive field H ; this will also be verified for the "baked" material.

Degaussing Range Studies

RESEARCHER: ASSOCIATE PROFESSOR WILLIAM E. FASNACHT

SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

Classified study of effectiveness of a sensor array for data input to mathematical modeling.

Low Temperature and High Pressure Electrical Properties of Ion-Conducting Polymers

RESEARCHERS: PROFESSOR JOHN J. FONTANELLA AND
ASSOCIATE PROFESSOR MARY C. WINTERGILL

SPONSOR: OFFICE OF NAVAL RESEARCH

The primary objective of the project is to measure the effect of high pressure and low temperatures on the electrical conductivity of ion-conducting polymers. The purpose of these measurements is to gain insight into the ion conduction mechanism in an attempt to increase the electrical conductivity at room temperature. The reason for studying such materials is that at present they are the most promising candidates for use as solid electrolytes in an all-solid state battery.

Additional information about the materials has also been obtained via electrical relaxation data, thermally stimulated depolarization measurements, differential scanning calorimetry, thermomechanical analysis, and infrared studies.

The materials studied to date include polydimethyl siloxane-ethylene oxide copolymers, poly(ethylene oxide), and poly(propylene oxide).

Analysis of Multilayered Structures by Rutherford Backscattering

RESEARCHER: ASSISTANT PROFESSOR JAMES R. HUDDLE
SPONSOR: NAVAL RESEARCH LABORATORY

A program was initiated to develop a technique for analyzing multilayered films using Rutherford Backscattering Spectrometry (RBS). The method uses elastic scattering of energetic helium ions by the Coulomb potentials of the target nuclei. A singly-charged helium ion beam of kinetic energy 2 MeV was extracted from the Naval Research Laboratory Van de Graaff Accelerator and was focussed and directed onto various multilayered targets. After scattering in the targets, the recoiling doubly-charged helium ions were analyzed with the NRL double-focussing magnetic spectrometer and detected with a solid state (surface barrier) particle detector. The spectrometer passes ions with recoil energy $E = kq^2B^2/m$ with a resolution of about 2%.

AlGaAs GaAs quantum well structures prepared by molecular beam epitaxy did not show multilayer structure by this method, presumably

because of the low Al concentrations in the AlGaAs layers. Mo Al multilayered films prepared by the RF evaporation technique at Virginia Polytechnic Institute and State University also failed to show the expected structure, presumably because of the unevenness of the layers in the film. Spectra taken with a 31 A Nb 26 A C x-ray analyzer do show multilayer structure qualitatively in agreement with theoretical predictions, but the data have not yet been quantitatively fit to the theory provided by the RBS simulation program RUMP.

This method is expected to have application to the analysis of surface layers prepared for ion beam mixing studies, to the measurement of Langmuir-Blogett films which can be used as x-ray diffraction analyzers, and eventually to the measurement of layer thicknesses in quantum well and other solid state electronic devices.

Investigation of Some Aspects of Performance of a TDR/TLI Probe

RESEARCHER: PROFESSOR RICHARD L. JOHNSTON
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The researcher investigated some of the variables associated with the physical and electrical design of

a TDR/TLI probe used as a fuel indicator aboard naval vessels.

Nonlinear Scattering of Crossed Ultrasonic Focussed Beams in the Presence of Turbulence

RESEARCHER: ASSOCIATE PROFESSOR MURRAY S. KORMAN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

An experimental scattering arrangement involving the nonlinear interaction of two mutually perpendicular intersecting beams (frequencies $f_1=2.1$ MHz and $f_2=1.9$ MHz), overlapping in a region of turbulence is investigated. In the absence of turbulence no radiated scattered intensity can exist (at the sum frequency $f_s=4.0$ MHz) unless wave fronts from each beam interact collinearly. Instrumentation has been designed and built to perform the nonlinear crossed beam experiment using focussed sound beams that overlap in the presence of turbulence in water. The apparatus consists of mechanical parts that allow for alignment and precise positioning of two overlapping focussed beams that can be made to scan across a region of turbulence. Turbulence is produced by a submerged jet nozzle that is attached to a plenum tank. Screens and honeycomb

placed in the plenum minimize turbulence produced in the pump and plumbing lines. A cylinder placed in the interaction region (no turbulence) is used for alignment purposes. The 4 MHz receiving transducer is connected to band pass filters and then to a spectrum analyzer which detect scattered sound waves at the sum frequency.

This apparatus will be used to compare the nonlinearly generated sum frequency intensity as a function of location across the turbulent jet. A correlation of sound intensity will then be made with existing models of the turbulence jet fluid. Measurements will also be made of sound intensity as a function of nozzle exit velocity.

Experiments will continue under the United States Naval Academy Trident Scholar Program in 1987-1988.

Electromagnetic Sensing

RESEARCHER: PROFESSOR FRANK L. MILLER
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER,
ANNAPOLIS LABORATORY

The researcher worked with the electromagnetics branch in connection with testing shipboard equipment for magnetic fields. The project involved exploring ways of excluding "Bad" measurements in a statistically valid way to speed up the testing pro-

cess. Present activity concentrates on testing equipment fields with portable magnetometers to examine the feasibility of developing on-site testing. Results are classified. Work will continue the coming year.

Ultrasonic Wear Particle Sensing

RESEARCHER: ASSOCIATE PROFESSOR DAVID A. NORDLING
SPONSOR: DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
ANNAPOLIS LABORATORY

The researcher developed and tested a 3-axis transducer array to distinguish soft and hard particulates,

and developed ultrasonic flow detection in fluid flowing in pipes.

HF/DF Laser Analysis

RESEARCHER: PROFESSOR CHARLES W. RECTOR

SPONSOR: NAVAL RESEARCH LABORATORY

This project consists of preparing as complete a list as possible of the experimental values of the fundamental and overtone vibration rotation spectral lines of hydrogen fluoride gas. The values obtained from various sources will be weighted and averaged so as to obtain "best values." These will then be used to obtain an optimum set of modified Dunham coefficients, using a convenient expansion scheme (RKR, SPE, or PMO). The lacunae in the experimental spectral regions will be filled in with computed values of the spectral lines.

In conjunction with the resulting spectral list, one of the objectives is to obtain the energy levels of the HF ground manifold, $X^1\Sigma^+$, so as to have a set of term values from which possible vibration rotation transitions can be calculated. A data base management program can be written to do these calculations for whatever range of wavelengths (wave numbers) and set of overtones, etc. are desired. This data base and recovery system could then be packaged in a single floppy disk for easy accessibility.

III-V Semiconductor Properties

RESEARCHER: PROFESSOR ROBERT N. SHELBY

SPONSOR: NAVAL RESEARCH LABORATORY

In FY86 the work was divided between system development and data gathering and analysis on GaAs and Ga-Al-As.

The 1 megahertz DCTS systems at Naval Research Laboratory were improved by construction of second copies of the bias pulsing and the pulse blanking and baseline restoration circuits. These changes enable greater data gathering rates. Additional system development work was done at the

Naval Academy, where a closed cycle helium refrigerator system will allow DCTS runs in the 15k to 80k temperature range, which is not easily reached by the NRL systems. Results of DCTS measurements on neutron irradiated Ga-Al-As have proved difficult to analyze due to surface defects, but samples with cleaner surfaces are currently being studied. Work on ion implanted GaAs is continuing.

Transient Stimulated Raman Scattering

RESEARCHER: ASSOCIATE PROFESSOR LARRY L. TANKERSLEY

SPONSOR: NAVAL RESEARCH LABORATORY

The project's goal is to complete a systematic study of transient Raman amplification. To date, pulse timing, gain suppression, pulse train development, spectral characteristics, and temporal characteristics of the Raman amplification process have been stud-

ied. Additional experiments are in progress to study beam quality and wave front preservation. New analytic formulas were developed to describe Raman scattering in the transient limit.

Nuclear Magnetic Resonance in Gallium Arsenide

RESEARCHER: PROFESSOR DONALD J. TREACY
SPONSOR: NAVAL RESEARCH LABORATORY

The purpose of the research was to obtain information which will be useful in the Navy's program developing III-V semiconductors. The immediate objective was to obtain information on the local environment of isovalent impurities which have been deliberately introduced into semi-insulating GaSa. The technique used in the investigation was Nuclear

Magnetic Resonance (NMR) because it is an extremely sensitive probe of the local environment of the resonant atom. The results suggest that the isovalent impurities do not cluster and that their main effect upon the host lattice is through the strain which they introduce.

Optical Measurement of the RMS Roughness of Ion-Bombarded Materials

RESEARCHER: MIDSHIPMAN 1 C CHARLES D. FERGUSON II
ADVISER: ASSOCIATE PROFESSOR FRANCIS D. CORRELL
SPONSOR: TRIDENT SCHOLAR PROGRAM

The major goals of this project were: (1) to construct and test a simple and inexpensive optical instrument for measuring the root-mean-square (rms) roughness of ion-bombarded materials and (2) to use the in-

strument to analyze several novel materials produced by the Materials Modification and Analysis Branch at the Naval Research Laboratory (NRL).

Nuclear Magnetic Resonance in Gallium Arsenide

RESEARCHER: MIDSHIPMAN 1 C MICHAEL F. FINCH
ADVISER: PROFESSOR DONALD J. TREACY
SPONSOR: TRIDENT SCHOLAR PROGRAM

The purpose of the research was to obtain information which will be useful in the Navy's program developing III-V semiconductors. The immediate objective was to obtain information on the local environment of isovalent impurities which have been deliberately introduced into semi-insulating GaAs. The technique used in the investigation was Nuclear Magnetic Resonance (NMR), because it is an ex-

tremely sensitive probe of the local environment of the resonant atom. The results suggest that the isovalent impurities do not cluster, and that their main effect upon the host lattice is through the strain which they introduce. This is an ongoing project here and in cooperation with the Naval Research Laboratory.

Independent Research

Instellar Gas in the Galactic Halo

RESEARCHER: ASSISTANT PROFESSOR C. ELISE ALBERT

The aim of this program which is being carried out in collaboration with Dr. D. C. Morton, Director, Herzberg Institute of Astrophysics, and Dr. J. C. Blades, European Space Agency and Space Telescope Science Institute, is to carry out a high resolution spectroscopic study of instellar gas in the galactic halo by observing the absorption lines of CaII, TiII, and NaI superimposed on the spectra of high latitude stars. This program was granted observing time at the 3.6 meter Canada-France-Hawaii Telescope in March 1987, and spectra of more than 24 stars were

obtained with a CCD detector at the coude focus of the telescope. These data will be analyzed during the summer of 1987 and will double the number of halo lines of sight probed at highest resolution. In addition, this project has been granted further observing time in the Fall of 1987 at the Canada-France-Hawaii Telescope and, to obtain complementary neutral hydrogen data, at the National Radio Astronomy Observatory in Green Bank, West Virginia.

Technical Feasibility Study of a Ground-Based Anti-Satellite Laser

RESEARCHER: LIEUTENANT MICHAEL J. CONNOLLY, USN

This research is a Strategic Defense Initiative related project studying the possibility/feasibility of development (by the Soviet Union) of an effective

ground-based laser capable of anti-satellite employment. (One particular design was focused on in this study.)



Study of Nuclear Forces and Reaction Mechanisms in Few-Nucleon Systems

RESEARCHER: ASSOCIATE PROFESSOR FRANCIS D. CORRELL

Few-nucleon systems provide an interesting "laboratory" in which to study nuclear forces and theoretical descriptions of nuclear reaction mechanisms. The short-range interaction of three nucleons can now be treated exactly by solving the Faddeev equations numerically, and some progress has been made toward extending this method to the four-nucleon system. For systems containing five to about seven nucleons, a different approach has been tried: some processes in these systems seem to be described quite well in terms of interactions between three composite bodies, whose actual nucleon structure need not be fully taken into account, but can often be adequately represented by phenomenological interaction potentials between them. The interaction of these three composite objects can then be calculated "exactly" using the Faddeev formalism. It is interesting to ask how well this "three-body model" (3BM) of few-nucleon interactions can reproduce the experimental data, and to what extent the properties of the nucleon-nucleon interaction can be deduced

from requirements imposed on the phenomenological potentials.

The goal of the present research has been to obtain experimental data under conditions that are expected to provide stringent tests of both the 3BM and the phenomenological potentials used. In particular, the data sought consist of cross sections and polarization analyzing power for both elastic scattering and multiparticle breakup reactions in systems composed of five to seven nucleons.

In 1984, a study of the six-nucleon system was begun by measuring the cross section and analyzing powers for the reaction ${}^4\text{He} (d, \alpha p)n$. These experiments were conducted at the Indiana University Cyclotron Facility using 69-MeV polarized neutrons. During the analysis of the data, it became clear that additional information on d, α elastic scattering at 69 MeV was needed to resolve certain ambiguities. The necessary measurements were made at Indiana University from 24–29 September 1986, and the new data are now being incorporated into the analysis.

Magnetospheric Physics

RESEARCHER: ASSOCIATE PROFESSOR IRENE M. ENGLE

The researcher adapted a set of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets with intrinsic planetary magnetic fields. Present work involves formulating a theory to explain the existence of a "sudden" physically extensive cometary ion tail in Kohoutek, as imaged by the Naval Research Labora-

tory camera. Other research tasks include modeling, from first principles, or by scaling from a function set, a self-consistent global magnetosphere of Uranus, and taking a new look at the Mercury magnetospheric field, in response to a recently published review which contains some conclusions which are not supported by this investigator's experience.

EFPEBFP (Ertel's Fool-Proof Eye-Ball Fitting Package)

RESEARCHER: ASSISTANT PROFESSOR JOHN P. ERTEL

Development in this area has proceeded steadily for several years awaiting the state-of-the-art to catch up and provide an adequate and acceptably priced computational and display environment. A real-time interactive process has been developed for use in fitting multi-variate functions to experimental observations. The "fit" is generated real-time on any computer linked to any graphics display device either in color or on multiple two or more memory planes. First the graph frame (coordinate axes, tick marks, and axis labeling) is drawn, followed by the data

and appropriate error bars. These are frozen in one color memory plane. Next, the proposed algorithm or model is evaluated over the range of the data to produce a curve in another color or memory plane which may be dynamically varied according to the current values of the fit parameters. These two plots, one fixed and one changing, are superimposed on the user's display. Using joysticks or other input devices, the application user then "tlys" the resulting curve to match the data giving "the most optically pleasing" fit while monitoring the reduced $-\chi^2$.

A Study of Photogates

RESEARCHERS: ASSISTANT PROFESSORS JOHN P. ERTEL AND EUGENE P. MOSCA

Using commercially available photogates commonly used in laboratories, the researchers conducted as complete an investigation as possible into the quality of this measurement device. The spatial as well as temporal sensitivities of these devices have been explored, showing some strengths (robustness as well as many weaknesses as they are typically used). A "sweet area" was found, a spatial region which, while *not centrally located* as one might suspect, allows

the photogate to produce values which are significantly closer to the "true," micrometrically measured, sizes of standard occluding objects. With the exception of some photogates which are obviously damaged and/or misaligned, the researchers found a consistent underestimate in lengths measured by these devices, which is of the order 10% and is sometimes 25% or higher.

Scattering of an Ultrasonic Beam by a Cloud of Microbubbles

RESEARCHER: ASSOCIATE PROFESSOR MURRAY S. KORMAN

This project was conducted with the assistance of Ms. Susan Moury, under the auspices of the Mentorship Volunteer Program of the Anne Arundel County public schools. Ultrasonic pulses of 20 microsecond duration are transmitted by a one-inch diameter circular piston transducer of carrier frequency 2.1 MHz. The acoustic pulses incident on a cloud of bubbles are scattered and are measured by a receiving transducer (of similar construction to the sender). Scattered sound pulses are measured as a function of scattering angle. The detected pulses are stored on a Norland Digital Oscilloscope (the

Prowler), and computations are performed to compute the average acoustic energy scattered as a function of angle. Results show that the relative scattered energy has much structure in its angular behavior since there are many peaks and valleys in the energy vs angle data plot. The cloud of microbubbles is produced by electrolysis from a one-inch square (1/8 inch mesh) platinumized metal screen placed at a minus 16 volt potential difference with the water. Future experiments will involve scattering results at other carrier frequencies.

Research Course Projects

UBV Photometry

RESEARCHER: MIDSHIPMAN 1 C DAVID A. BEEMER

ADVISER: ASSISTANT PROFESSOR C. ELISE ALBERT

The purpose of this project was to develop a systematic program of photometry of variable stars with the Naval Academy's 16" reflecting telescope and broad band photoelectric photometer. The student researcher organized and developed the

photometric system, studied the light curve of an eclipsing binary star, and produced a comprehensive manual introducing the basic concepts of variable star photometry and giving practical instruction for the Academy's astronomy equipment.

Sample Preparation and High Pressure Electrical Properties of Ion-Conducting Polymers

RESEARCHER: MIDSHIPMAN 2 C CHARLES R. BINGHAM II

ADVISER: PROFESSOR JOHN J. FONTANELLA AND

ASSOCIATE PROFESSOR MARY C. WINTERSGILL

The primary objectives of the project were to prepare samples of certain ion-conducting polymers and to measure the high pressure electrical properties of others. The samples to be prepared were low molecular weight poly(ethylene oxide) (PEO) complexed with a variety of salts. The reason for studying low molecular weight material is for comparison with the results for high molecular weight samples which have already been obtained. Several materials were solution cast and prepared for the pressure

dependence of the electrical conductivity for poly(propylene oxide) (PPO) complexed with lithium trifluoroacetate and PEO complexed with lithium trifluoromethanesulfonate. In the case of PPO, the objective was to study another anion with a dipole moment. For PEO, the objective was to do the first complex impedance measurements at high pressures. In both cases, the measurements have been performed and the results are being analyzed.

Construction of a High Pressure Differential Thermal Analyzer

RESEARCHER: MIDSHIPMAN 1/C GUY M. BRADEN

ADVISERS: PROFESSOR JOHN J. FONTANELLA AND

ASSOCIATE PROFESSOR MARY C. WINTERSGILL

The objective of the project was to construct a high pressure differential thermal analyzer. The principle is to monitor the temperature of a sample while the temperature of the surroundings is changed at a constant rate. Commercial equipment is not available for such measurements at pressures of thousands of atmospheres. The first step was to design and construct a pressure vessel and equip it with the appropriate electrical feedthrough. Next, the circuit for

ramping temperature and monitoring the temperature of the sample was designed and assembled. Finally, the pressure system for achieving and maintaining gas pressures up to 2000 atmospheres and liquid pressures up to 15,000 atmospheres was designed and constructed. Several preliminary data runs were made with the system and various phase transitions were observed.

Nonlinear Scattering of Crossed Ultrasonic Focussed Beams in the Presence of Turbulence

RESEARCHER: MIDSHIPMAN 2 / C STEPHEN C. RIFE
 ADVISER: ASSOCIATE PROFESSOR MURRAY S. KORMAN

The acoustics experiments pursued by Associate Professor Korman under sponsorship of the Naval Academy Research Council (ONR) were performed

jointly with Midshipman 2 / C Rife under the Research Course Program.

Ultra Low Frequency Complex Impedance Analysis

RESEARCHER: MIDSHIPMAN 1 / C JOHN T. WALTERS II
 ADVISERS: PROFESSOR JOHN J. FONTANELLA AND
 ASSOCIATE PROFESSOR MARY C. WINTERSGILL

The objective of the project was to interface a Princeton Applied Research Potentiostat Galvanostat with an Apple II microcomputer and use the instrument to make complex impedance measurements over the frequency range 5 mHz to 10 Hz. The instrument would then complement the existing equipment which is capable of state-of-the-art measurements over the frequency range 10-100,000 Hz. The use

for the instrument is to allow a complete evaluation of the electrical properties of materials. The appropriate interface was obtained for the computer and connected to the analyzer. A satisfactory link was made between the instruments; however, only limited progress was made in performing complex impedance measurements.



Publications

ALBERT, C. Elise, Assistant Professor, co-author, "Multispectral Observations of FIRSSE Source I—Radio Observations of Optically Identified Objects," *The Astronomical Journal*, 92 (July 1986), 75-78 and plates 3-10.

Very Large Array radio maps of eight HII regions detected in the Air Force Geophysics Laboratory/Naval Research Laboratory Far Infrared Sky Survey Experiment (FIRSEE) are compared to their optical images. The radio morphologies are consistent with "champagne flows." Infrared Astronomical Satellite (IRAS) photometry shows that all of these objects have luminosities which are less than or comparable to those of zero-age main sequence stars.

ALBERT, C. Elise, Assistant Professor, co-author, "The Circumstellar Gas Cloud Around Beta Pictoris II," *Astronomy and Astrophysics*, 167 (1986), 325-332.

A detailed analysis is presented of the circumstellar components of the K line of CaII and the D lines of NaI recorded in new, high quality echelle spectra of Beta Pictoris. The K line is wider than the D lines, and there is a velocity difference of 2 km/sec between the approximate centers of the lines of the two species which is accommodated by fitting the observed lines with two-component theoretical profiles. Two models for the circumstellar gas cloud are developed.

ALBERT, C. Elise, Assistant Professor, "Optical Observations of the z-Structure of the Lower Halo," *Gaseous Halos of Galaxies: Proceedings of a National Radio Astronomy Observatory Workshop*, Green Bank, West Virginia, 30 May-1 June 1985, (1986), 37.

A review is presented of current observations of the large scale gaseous structure of our galactic halo, and fundamental problems are discussed. Evidence is presented for two types of neutral interstellar gas in the lower galactic halo which are characterized by distinct distribution kinematics and abundances: a thick low-velocity disk and additional higher velocity, much less strongly depleted, gas observed only at high z-distances. Important questions left for the future are outlined.

BRILL, Donald, W., Professor, co-author, "Resonance Theory of Elastic Waves Ultrasonically Scattered From An Elastic Sphere," *Journal of the Acoustical Society of America*, 81, 1 (January 1987), 1-21.

The interaction of elastic waves incident on an elastic spherical inhomogeneity is studied in detail, particularly in the resonance scattering regime. Incident and scattered compression and shear waves in lossless elastic media separate into three modes: a p mode for the compression wave, and s and t modes for the shear wave. A description of how the acoustic energy redistributes among these modes during the scattering process is contained in the scattering matrix that the authors separate here into background and resonance portions for the two extreme cases of a nearly rigid elastic sphere. This produces farfield scattering amplitudes which are a superposition of a background contribution felt to contain reflected and Franz-type circumferential waves and a resonance contribution that seems to contain refracted, Rayleigh, and whispering gallery waves. Limiting cases (a fluid sphere in an elastic medium, an elastic sphere in a liquid medium, and a fluid sphere in a fluid medium) are extracted from these results to show agreement with previous work. Plots show the background and resonance portions of the scattered amplitudes and their connections with the poles of the scattering amplitude in the complex frequency plane.

CORRELL, Francis D., Associate Professor, co-author, " **$^4\text{He} + ^4\text{He}$ Reaction Cross Sections at 17.9, 21.7, and 24.0 MeV**," *Physical Review C*, 35 (1987), 383-392.

The total reaction cross section σ_R for $^4\text{He} + ^4\text{He}$ has been obtained at laboratory bombarding energies of 17.9, 21.7, and 24.0 MeV by measuring the individual cross sections for production of protons, deuterons, tritons, ^3He , and α particles. The accuracy of the results is greatly improved by taking advantage of a novel method which depends on the symmetry about 90° in the center-of-mass system of the reaction cross sections for identical particles in the incoming channel. Use of this method reduces the range of energy and angle which must be measured for the continuous spectra of particles emitted in these multibody final states. In order of increasing energy, the values of σ_R obtained in this experiment are 156.7 \pm 3.8, 250 \pm 14, and 296 \pm 12 mb. Individual cross sections contributing to σ_R were also extracted. Implications of the measurements for resonating group calculations of $^4\text{He} + ^4\text{He}$ scattering are examined.

CORRELL, Francis D., Associate Professor, and Charles D. FERGUSON, Midshipman 1/C, "**Optical Measurements of the RMS Roughness of Ion-Implanted Surfaces**," *Nuclear Instruments and Methods in Physics Research*, B24-25 (1987), 581-583.

Ion implantation and other ion-beam processing techniques sometimes roughen the surfaces to which they are applied. If undetected, such roughness can lead to erroneous interpretation of data gathered by RBS, AES, and other surface analysis techniques. Many surface profilometers and scanning electron microscopes lack sufficient resolution to detect fine-scale roughness that can complicate the data interpretation. The authors have constructed a simple

optical instrument to measure the root-mean-square (rms) roughness, below ~ 100 nm, of ion-implanted surfaces. This instrument measures the total integrated scatter (TIS) of almost-normally incident laser light, which (under certain conditions) is simply related to the rms surface roughness. This paper describes the construction and calibration of the TIS instrument, and presents preliminary results on the roughness of Cr surfaces deposited under various vacuum conditions and implanted during deposition with energetic Cr ions.

ELDER, Samuel A., Professor, "**Comments on 'Sound Generation By Flow Over Relatively Deep Cylindrical Cavities'**," *Journal of the Acoustical Society of America*, 80, 5 (November 1986), 1530-1531.

A solution for the Strouhal numbers of flow-excited deep cavity tones, given by Parthasarathy et al., is incorrect, in that it overpredicts the number of self-sustained modes. The correct formula, taken from an earlier paper by Elder, predicts only those modes capable of supporting self-sustained oscillation.

HUDDLE, James R., Assistant Professor, "**Multiply-Charged Heavy Ion Beams from a 'Dirty Bottle' Ion Source in a Single-Ended Van de Graaff**," *Nuclear Instruments and Methods B*, April 1987, and *Bulletin of American Physical Society*, 31 (1986), 1291.

With only simple modifications, standard radiofrequency (rf) ion sources can be used in single-ended Van de Graaff accelerators to produce useful currents of argon ion beams of charge up to $+5$. If the ion source discharge bottle is "dirty" from previous use, multiply-charged ion beams of the contaminants are also observed in useful quantities with pure argon as the source gas, although the contaminant beams may interfere with control of the machine on the argon beams.

KORMAN, Murray S., Associate Professor, "Non-linear Scattering of Crossed Ultrasonic Beams in the Presence of Turbulence - Intensity Measurements Versus Turbulent Mach Number," *Journal of the Acoustical Society of America*, 80, S88 (December 1986), QQ1.

An experimental scattering arrangement involving the nonlinear interaction of two mutually perpendicular intersecting beams (frequencies $f_1=2.1$ MHz and $f_2=1.9$ MHz), overlapping in a region of turbulence is investigated. In the absence of turbulence no radiated scattering intensity I_r is observed at the combination frequency $f_r=4$ MHz. However, in the presence of turbulence, scattering is observed at f_r . This radiated component shows considerable amplitude modulation and exhibits spectral broadening. The experiment is performed in a 12 ft deep \times 20 ft \times 20 ft section of the U.S. Naval Academy's Hydromechanics Tow Tank facility. Two 2.54 cm-diameter transducer units are pulsed at f_1 and f_2 , respectively. They are both located 1 m from the interaction region X and form a plane with a 4 MHz receiving unit located (in cylindrical coordinates) 3 m from X at the angular position of 45° from the axis of both sending beams. A 4.81-cm-diameter submerged nozzle is aimed perpendicular to the crossed beam plane and located 20 nozzle diameters above it. Measurements of the scattered intensity I_r versus nozzle exit velocity U_0 , show that $I_r \propto U_0^{1.2}$ over the range 27-62 ft/s. U_0 can be related to turbulent fluctuations in the interaction volume. Theory and experiment, for I_r , lead to predictions of an average turbulent length scale dependence on Reynolds number. The sensitivity of detecting turbulence with this apparatus is discussed and measurements of spectral broadening versus U_0 will be presented.

RECTOR, Charles W., Professor, "Interaction of Intense 2 Microsecond Pulse Time, 2.7 Micrometer Wavelength Laser Beams with 6061-T6 Aluminum Sheet," *Proceedings of the Defense Nuclear Agency/American Institute of Aeronautics and Astronautics, Laser Effects and Target Response Meeting*, 5-7 November 1985, Stanford Research Institute International, Menlo Park, California, pp. 71-82.

MIJOLLINIR, an Air Force Weapons Laboratory pulsed HF Chemical Laser, was used to irradiate 6061 T6 aluminum sheets under conditions of high intensity (50-300 MW/cm²). Measurements were made of impulse and permanent plate deflections. Although the relationship between impulse and irradiation was in agreement with theory, the permanent plate deflections were so much less than that theory predicts that the thermal-mechanical mechanism is unlikely to be important for Navy scenarios. This conclusion is in agreement with the observations that repetitive 10.6 μ m CO₂ laser pulses lower the penetration temperature of a thin aluminum sheet by only about 45° C below the solidus temperature.

TANKERSLEY, Lawrence, L., Associate Professor, co-author, "Parametric Raman Gain Suppression in D₂ and H₂," *Optics Letters*, (December 1986), 11-12.

The author reports direct experimental evidence of the absence of exponential gain at the Stokes wavelength for Stokes anti-Stokes phase-matched stimulated Raman scattering. The amplification of a Stokes seed pulse was measured at various propagation angles relative to the pump direction. Non-exponential growth was observed at the Stokes/anti-Stokes phase-matching angle, with an amplification that was smaller than at non-phase-matching angles by a factor of more than 10. This article received an Alan Berman research publication award from the Naval Research Laboratory.

TREACY, Donald J., Professor, co-author, "Nuclear Magnetic Resonance Measurements of Lattice Distortions in GaAs:In," *Applied Physics Letters*, 49 (September 1986), 528.

Nuclear magnetic resonance (NMR) has been used to probe the atomic displacements and bond bending around an isovalent impurity (In) in the GaAs lattice. It is concluded that the In atoms substitute on the Ga sublattice, that they do not cluster, and that the strain field induced by these isolated atoms is sufficient to affect the NMR of arsenic atoms as far away as 30 Å. Estimates of bond angle distortions in the nearest atomic shells around the In atom are discussed.

TREACY, Donald L., Professor, co-author, "NMR Measurements of The Local Structure of $\text{Al}_{1-x}\text{Ga}_x\text{As}$," *Bulletin of the American Physical Society*, 32 (March 1987), 691.

Recent electron diffraction measurements have shown that the cation lattice is ordered in certain $\text{Al}_{1-x}\text{Ga}_x\text{As}$ films. The authors report here the first NMR measurements on MBE-grown films $\text{Al}_{1-x}\text{Ga}_x\text{As}$ alloys. In this work the interaction of the nuclear electric quadrupole with the electric field gradient at the nucleus is used to probe the local structural units and thereby to detect the presence of ordering in these films. The ^{69}Ga and ^{75}As spectra exhibit first order quadrupole effects, indicating that there are very small deviations from tetrahedral symmetry even for this nearly perfect lattice-matched alloy. Preliminary results for the observed symmetry of the electric field gradient tensor indicate residual ordering (departures from randomness) in the cation sub-lattice of the alloy.

WINTERSGILL, Mary C., Associate Professor, John J. FONTANELLA, Professor, and Michael K. SMITH, Lieutenant, USN, "Ionic Conductivity in Solid, Crosslinked Dimethylsiloxane-Ethylene Oxide Copolymer Networks Containing Sodium," *Journal of Applied Physics*, 60 (15 August 1986), 1342-1345.

The preparation of an ion-conducting elastomeric solid based on a dimethylsiloxane-ethylene oxide copolymer complexed with a sodium salt is described. ^{23}Na NMR measurements reveal the presence of both bound and mobile sodium species throughout the temperature range -120 to 100°C . Electrical conductivity measurements over a similar temperature range are found to be consistent with the configuration entropy model for transport, with a T parameter about 50°C below the "central" glass transition temperature T_g .

WINTERSGILL, Mary C., Associate Professor, John J. FONTANELLA, Professor, Michael K. SMITH, Lieutenant, USN, and Jeffrey D. SEMANCIK, Ensign, USN, "The Effect of High Pressure on Electrical Relaxation in PPO and Electrical Conductivity in PPO Complexed with Lithium Salts," *Journal of Applied Physics*, 60 (15 October 1986), 2665-2671.

Audio frequency electrical conductivity and relax-

ation studies have been carried out on PAREL elastomer and PAREL elastomer complexed with a variety of lithium salts. The measurements have been carried out in vacuum over the temperature range 5 – 380K and at pressures up to 0.65 GPa over the temperature range 230 – 380K . Both the electrical relaxation time associated with the A relaxation in the uncomplexed material exhibit VTF or WLF behavior. From a VTF analysis for both the vacuum electrical relaxation and electrical conductivity, E_a is found to be about 0.09 eV and T_o is found to be about 50°C below the "central" glass transition temperature. In addition, it is found that the activation volume for the electrical relaxation time and the electrical conductivity are the same when compared relative to T_o . These results imply that the mechanism controlling ionic conductivity is the same as that for the alpha relaxation, namely large scale segmental motions of the polymer chain.

WINTERSGILL, Mary C., Associate Professor, John J. FONTANELLA, Professor, and Michael K. SMITH, Lieutenant, USN, "NMR, DSC, TMA, and high pressure electrical conductivity studies in solid, crosslinked dimethylsiloxane-ethylene-oxide copolymer networks containing sodium," *Polymer*, 28 (April 1987), 633-639.

Audio frequency electrical conductivity and ^{23}Na NMR studies have been carried out on solid, cross-linked dimethylsiloxane-ethylene oxide copolymer networks containing sodium. The electrical measurements have been carried out in vacuum over the temperature range 5 – 380K and at pressures up to 0.65 GPa over the temperature range 230 – 380K . The electrical conductivity exhibits VTF or WLF behavior. From a VTF analysis, E_a is found to be about 0.11 eV and T_o is found to be about 45°C below the "central" glass transition temperature as determined by both DSC and TMA. Also, T_o is found to increase about 50 K/GPa and E_a increases significantly with pressure. In addition, the high pressure studies show that the activation volume associated with the electrical conductivity decreases from 44 to $23\text{ cm}^3/\text{mol}$ over the temperature range 262 – 323K . The ^{23}Na NMR measurements reveal the presence of both bound and mobile sodium species, the temperature range -100 to $+100^\circ\text{C}$. Broadening of the bound ^{23}Na line above room temperature suggests the possible presence of ion pairs or higher aggregates in the complex.

Presentations

BEAM, David A., Lieutenant, USN, John J. FONTANELLA, Professor, Mary C. WINTERSGILL, Associate Professor, and Douglas FIGUEROA, Visiting Professor, "Electrical Relaxation in Calcium Fluoride Doped with Thorium and Zirconium" Fifth Europhysical Topical Conference on Lattice Defects in Ionic Crystals, San Lorenzo de el Escorial Madrid, Spain, 8-12 September 1986.

BRILL, Donald W., Professor, "Resonance Theory of Elastic Waves Scattered From an Elastic Sphere," Twelfth International Congress on Acoustics, Toronto, Canada, 24-31 July 1986.

CALAME, Gerald P., Professor, and Lawrence L. TANKERSLEY, Associate Professor, co-authors, "Raman Gain Buildup in a Pulse Train," Conference on Lasers and Electro Optics, Baltimore, Maryland, 29 April 1987.

CORRELL, Francis D., Associate Professor, "Materials Analysis with Energetic Ion Beams," David W. Taylor Naval Ship Research and Development Center, Annapolis, Maryland, 18 June 1986.

CORRELL, Francis D., Associate Professor, "Optical Measurement of the RMS Roughness of Ion-Planted Surfaces," Ninth Conference on the Application of Accelerators in Research and Industry, Denton, Texas, 11 November 1986.

ELDER, Samuel A., Professor, "Self-Excited Oscillations in Deep Cavities," Conference on Pulsating Flows in Pipeline Systems, Calgary, Alberta, Canada, 25 September 1986.

ENGLE, Irene M., Associate Professor, "The 'Old Girl Network' as a Supplementary Support System," "Having It All: Personal Lives and Professional Choices," Institute of Optics, University of Rochester, 17 September 1986.

ERTEL, John P., Assistant Professor, "Fly Your Own Fit (or Game Graphics Techniques Come to Modeling)," Eighteenth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 24 April 1987.

FONTANELLA, John J., Professor, Mary C. WINTERSGILL, Associate Professor, and Michael K. SMITH, Lieutenant, USN, "DR, NMR, DSC, and High Pressure Electrical Conductivity Studies in Solid, Crosslinked Dimethylsiloxane-Ethylene Oxide Copolymer Networks Containing Sodium," Specialty Polymers '86, Baltimore, Maryland, 6-8 August 1986.

FONTANELLA, John J., Professor and Mary C. WINTERSGILL, Associate Professor, "Temperature and Frequency Dependent Dielectric Relaxation Behavior of a Siloxane Polymer Liquid Crystal," Specialty Polymers '86, Baltimore, Maryland, 6-8 August 1986.

FONTANELLA, John J., Professor, Mary C. WINTERSGILL, Associate Professor, David A. BEAM, Lieutenant, USN, and Douglas FIGUEROA, Visiting Professor, "Electrical Relaxation in Rare Earth-Doped Cadmium Fluoride," Fifth Europhysical Topical Conference on Lattice Defects in Ionic Crystals, San Lorenzo de el Escorial Madrid, Spain, 8-12 September 1986.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, "NMR, DSC, DMA, and High Pressure Electrical Conductivity Studies in PPO Complexed with Sodium Perchlorate," 170th Meeting of the Electrochemical Society, San Diego, California, 19-24 October 1986.

FONTANELLA, John J., Professor, Mary D. WINTERSGILL, Associate Professor, and Charles R. BINGHAM II, Midshipman 2/C, "High Pressure Electrical Conductivity and DSC Studies in PPO Complexed with Alkali Metal Salts," 1987 March Meeting of the American Physical Society, New York, New York, 16-20 March 1987.

FONTANELLA, John J., Professor and Mary C. WINTERSGILL, Associate Professor, "Thermal and High Pressure Electrical Properties of Ion-Conducting Polymers," Meeting of the American Chemical Society, Denver, Colorado, 5-10 April 1987.

HUDDLE, James R., Assistant Professor, "Multiply-Charged Heavy Ion Beams from a 'Dirty Bottle' Ion Source in a Single-Ended Van de Graaff," Ninth International Conference in the Applications of Accelerators in Research and Industry, Denton, Texas, 10-12 November 1986.

KORMAN, Murray S., Associate Professor, "Physical Acoustics VI: Sound Propagation in Inhomogeneous Media," 112th Meeting of the Acoustical Society of America, Anaheim, California, 8-10 December 1986.

MOSCA, Eugene P., and John P. ERTTEL, Assistant Professors, "Use of Photogates for Velocity Determination: An Instrument Evaluation," Annual Meeting, Central Pennsylvania Section of the American Association of Physics Teachers, Lancaster, Pennsylvania, 11 April 1987.

TANKERSLEY, Lawrence L., Associate Professor, co-author, "Raman Gain Suppression in D_2 ," Optical Society of America Annual Meeting, Seattle, Washington, 19-24 October 1986.

TANKERSLEY, Lawrence L., Associate Professor, and Gerald P. CALAME, Professor, "Multiple Pulse Effects in Transient Raman Amplifiers," Optical Society of America Annual Meeting, Seattle, Washington, 19-24 October 1986.

TANKERSLEY, Lawrence L., Associate Professor, co-author, "Transient Rotational Raman Amplification," Optical Society of America Annual Meeting, Seattle, Washington, 19-24 October 1986.

TANKERSLEY, Lawrence L., Associate Professor, co-author, "Transient Raman Amplification," Lasers 86, Orlando, Florida, 3-7 November 1986.

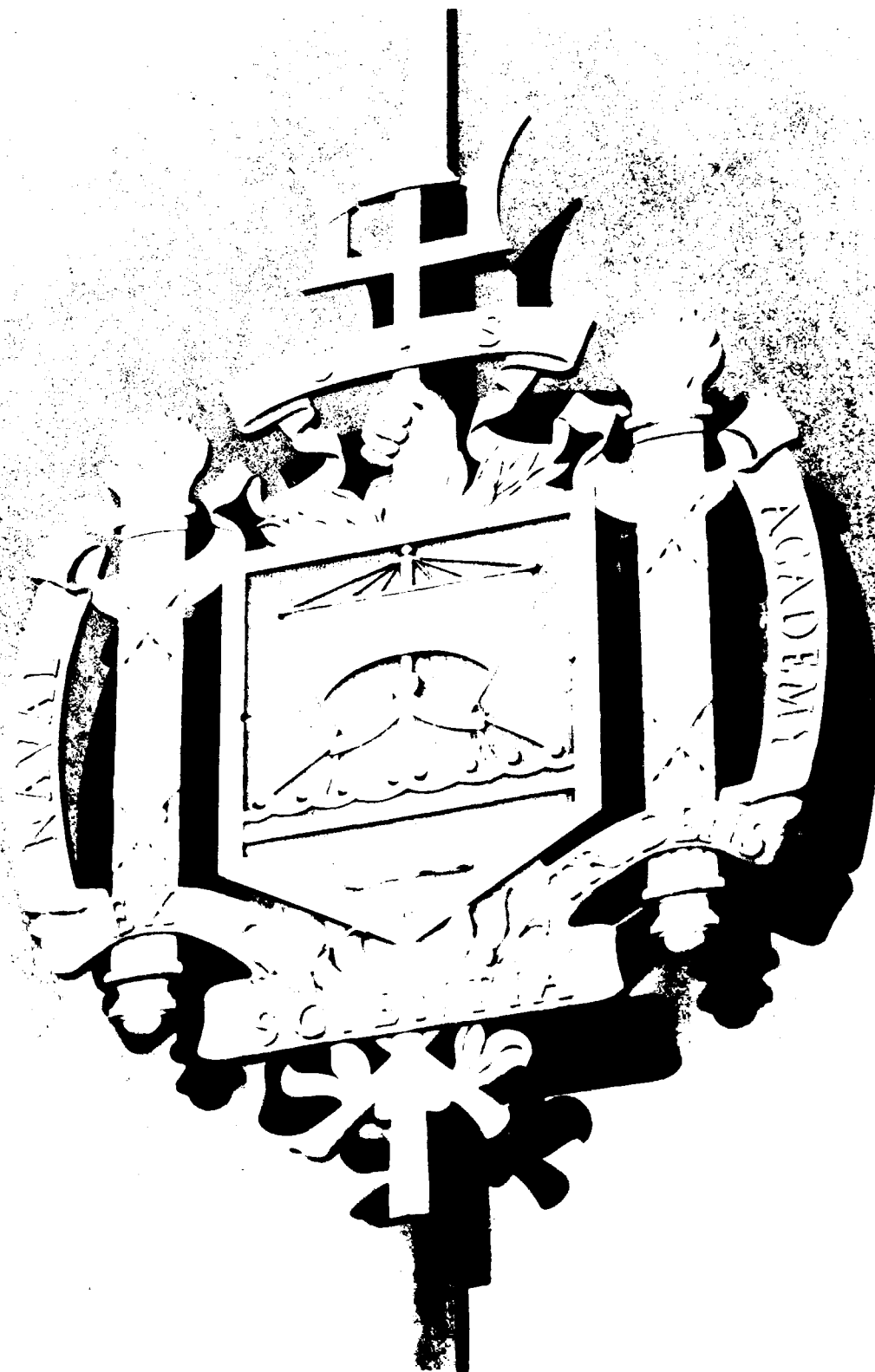
TANKERSLEY, Lawrence L., Associate Professor, co-author, "Transient Raman Amplifiers," Seventeenth Winter Colloquium on Quantum Electronics, Snowbird, Utah, 5-8 January 1987.

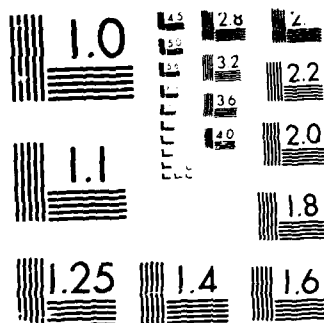
TANKERSLEY, Lawrence L., Associate Professor, co-author, "Phase Pulling in a Transient Raman Amplifier," Conference on Lasers and Electro Optics, Baltimore, Maryland, 26 April-1 May 1987.

TANKERSLEY, Lawrence L., Associate Professor, co-author, "Wavefront Preservation in Transient Raman Amplifiers," Conference on Lasers and Electro Optics, Baltimore, Maryland, 26 April-1 May 1987.

TREACY, Donald J., Professor, co-author, "NMR Measurements of the Local Structure of $Al_xGa_{1-x}As$," American Physical Society Meeting, New York, New York, 18 March 1987.

Division of Professional Development





MICROCOPY RESOLUTION TEST CHART
 1010-A



DEPARTMENT OF

Leadership and Law

COMMANDER DONALD J. CURRAN, JR., USN
CHAIRMAN

Members of the Leadership and Law Department conduct various kinds of applied research in support of institutional objectives. To this end, research is designed to enhance the professional development of midshipmen toward becoming effective and efficient leaders of tomorrow's fleet and Marine Corps.

While not reported in detail, the Department's ongoing efforts to determine the best way for counseling midshipmen and providing them with improved study materials continued throughout the academic year.



Sponsored Research

Coronary Artery Disease, Type-A Behavior Patterns and Naval Academy Midshipmen

RESEARCHER: ASSISTANT PROFESSOR ERIC D. BOWMAN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (ONR)

Since the early 1970s, researchers have studied a group of individuals described as having Type-A behavior patterns. It has been shown that these individuals are aggressive, competitive, and have strong achievement motivation. Researchers since the 70s have repeatedly shown that people with a Type-A behavior pattern have two to three times as many heart attacks as people with Type-B behavior patterns (easygoing, calm, relaxed). There is also evidence that Type-A individuals suffer from an increased incidence of atherosclerosis.

The admissions policy at the Naval Academy hinges on a very active program of recruiting highly competitive, aggressive, achievement-oriented individuals. During the four years at the Academy, midshipmen are taught the importance of competition, aggression, and achievement. Upon graduation, these same individuals are placed in an environment almost identical to the Academy in terms of the highly-charged and achievement-oriented climate. It is possible that the Naval Academy is actively recruiting and training individuals who have

a significantly higher chance of developing cardiac disease than the U.S. population as a whole.

This study has two phases. The initial phase was an examination of the prevalence of Type-A behavior patterns within the incoming Class of 1991. All midshipmen in the Class of 1991 were tested as part of the existing Background Psychological Testing Program coordinated through the Division of Professional Development. The results of this phase will answer the initial question of the presence and prevalence of Type-A behavior patterns within the Class of 1991.

The second phase of the study to be conducted during the 1987-1988 academic year will compare those subjects categorized as exhibiting Type-A behavior with a matched group of Type-B subjects on a high challenge task. Each group's physiological reactions will be measured in order to determine significant psychophysiological differences while performing in a stressful situation. The stressful situation in this study will be competition in a simulated combat scenario.



Independent Research

Midshipmen Time Budgets

RESEARCHER: VISITING PROFESSOR LEANNE ATWATER

The purpose of this study was to investigate how midshipmen spend their time and to assess their attitudes and values concerning their experiences at the U.S. Naval Academy.

Time budgets and attitude surveys were administered to the Brigade during the week 1-7 April 1987. Completed questionnaires were returned by 3785 midshipmen. These midshipmen recorded in minutes how much time they spent in each of 56 activities (e.g., grooming, classes, formation, studying, relaxing) during a particular 24-hour period. They also rated the importance of a number of aspects of their life (e.g., being in good shape physically, getting good grades, getting good professors) and indicated how likely they believed they would be to engage in various activities during their week-

end liberty time. Numerous findings, reported in a preliminary briefing, included:

- The average amount of time midshipmen spend studying *all* subjects combined during weekdays was 210 minutes a day.
- The hours midshipmen report they have available to study during the week was approximately 30. 50-65% of that time is productively spent studying.
- The average amount of sleep reported on weekdays was 410 minutes (sleep reported on the weekends was 530 minutes).
- There were no appreciable differences in the ways midshipmen with differing majors spent their time.

Data is still being analyzed.

Personality Assessment and Soccer Performance

RESEARCHER: ASSISTANT PROFESSOR ERIC D. BOWMAN

The study compares the personality factors derived from various personality tests administered by the U.S. Naval Academy on the performance of players on the Navy soccer team over a ten-year period. Sport performance will be determined by the number of minutes played by each player over four years. (The coach of the Navy soccer team has been the head coach for over ten years, adding to the consistency of the performance factor). A full analysis of all tests will be performed, including second order factors. The study, being longitudinal in nature, brings with it obvious advantages, including an eradication of the problem of the self-fulfilling prophecy referred to by Morgan.

It is expected that those players who accumulate more minutes played, (those who are more successful) will have different personality traits states than those who have played less. Knowledge of these "successful" traits may prove beneficial to teachers, parents, and coaches, as well as providing further evidence either to support or refute the ongoing personality sport argument discussed earlier.

The research was conducted with Andrew Jennings, a doctoral student at the University of Maryland.

Development of an NL303 Leadership Case Book

RESEARCHERS: LIETUENANT COMMANDER C. RANDY LARGE, USN AND PROFESSOR KAREL MONTOR

With the completion of the NL303 text, an effort was started, with guidance from General Wallace M. Greene, Jr., USMC (Ret.), former Commandant of the Marine Corps, to develop cases that would support the first 94 sections of the text. Midshipmen met individually with various officers, and from these discussions developed "real" cases that include

the estimate of the situation and factors affecting the decision, and then provide instructors and midshipmen with a base for relating the concepts of the text to appropriate problem solutions. It is anticipated that the first set of 94 cases will be ready for use during AY 1988-1989.

Development of Professional Training Programs

RESEACHER: PROFESSOR KAREL MONTOR

A major effort, supervised by the Programs Department of the Division of Professional Development, is underway to review the professional program for use with the Plebe Class. This is an effort conducted primarily by midshipmen, with the researcher pro-

viding administrative guidance as to product development, so that the end results will meet administration objectives within economical and efficient program presentation methods.

Developing a Myopia Avoidance Protocol and Research Program

RESEARCHER: PROFESSOR KAREL MONTOR

This long-range program continued with further contacts made with opthalmic researchers in the field. Statistically 50% of all students develop myopia (near sightedness) during their college careers, while at the U.S. Naval Academy this figure has remained somewhat constant at 20-25% for the last 40 years.

In preparation for full-scale testing of the concept of myopia avoidance through the use of plus lenses, a small intervention study has been designed for application with the Class of 1991.

Development of a New NL303 Leadership Text

RESEARCHER: PROFESSOR KAREL MONTOR

During Academic Year 1986-1987 the draft text was used in conjunction with the 2nd class leadership program, with midshipmen and instructor recommendations for revision incorporated into the final text to be published by the Naval Institute during

the Summer of 1987. The volume has received acclaim from leaders throughout the world and demonstrates that research can be done with a practicable and implementable result when those in the naval service set their minds to it.

Division of U.S. and International Studies





Economics

PROFESSOR J. ERIC FREDLAND
CHAIRMAN

Research activity of many of the faculty in the Economics Department continued to focus on national defense issues. There were several particularly noteworthy developments. The department co-sponsored, with the Competition Advocate General of the Navy, a conference on the economics of defense acquisition, which brought a number of the country's outstanding young theoretical economists together with civilians and officers in the defense procurement community. Dr. Oliver R. Grawe became the first occupant of the Acquisition, Supply, and Logistics Research Chair, sponsored by the Naval Supply Systems Command. Dr. John T. Warner was appointed to the Manpower, Personnel, and Training Research Chair, sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel and Training). Both visiting professors completed projects for their sponsoring agencies, as well as pursuing independent research interests. Results of their work were presented at departmental seminars and elsewhere. Professor Little and others combined with Professor Fitzgerald (Political Science) in several interdisciplinary efforts related to defense topics. Associate Professor Bowman began a two-year project on the fleet performance of Academy graduates. Other faculty members considered such diverse non-defense topics as the analysis of business cycles, the health risks of radon, the Federal Reserve payments mechanism, and agriculture in sub-Saharan Africa.



Sponsored Research

Cost-Benefit Analysis of an Office Automation Network

RESEARCHER: LIEUTENANT MICHAEL G. AUSTIN, SC, USNR

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

A cost-benefit analysis project for an office automation network was coordinated. Specifically, a technical survey to identify current and future requirements for word processing, electronic communications, and job performance aids was designed; a time allocation survey to quantify anticipated quality improvements in employee time allocation resulting from office automation configuration changes was designed; data bases associated with project surveys incorporating parametric and nonparametric statistical analyses were formatted; and an office automation baseline using present value cost analysis on expenditures was established. Study results indicated that a Hedonic Wage Model could effectively be used in

determining the value of a proposed office automation network if used in conjunction with a technical survey. The study rejected the practice of using a Hedonic Wage Model as a monitoring technique once a network had been installed, because repeated use of time allocation surveys was expected to result in time allocation being heavily biased toward higher work performance categories. A method for monitoring newly installed networks was developed using nonparametric analyses based on the performance level of the network rather than that of the individual. As a consequence of this project, a paper was presented at the 1987 Institute of Cost Analysis National Educational Symposium.

Modeling Fleet Performance of Academy Graduates

RESEARCHER: ASSOCIATE PROFESSOR WILLIAM R. BOWMAN

SPONSOR: CHIEF OF NAVAL RESEARCH (OP-01)

A two-year project was begun, which is designed to assess the importance of ability, schooling, and experience to the performance of U.S. Naval Academy graduates of the classes 1976 through 1980. The objective of the project is to develop quantitative measures of individual performance of officers during the fifth year of active duty service and relate such performance to previously known information on each individual.

In particular, the research project is designed to determine the relative importance of the abilities and achievements of each individual with respect to officer fitness reports data. The abilities, achievements

are measured separately during three prior phases for each individual—high school and prep school, attendance at the Naval Academy, and the first four years of fleet experience.

A large pooled cross-section/times-series data base has been developed during the first phase of the project. Individual data have been merged from U.S. Naval Academy admissions data, Academy military, academic, and athletic performance data, officer data from a master/loss data file, and continuous longitudinal officer fitness reports data. Analysis of this data base will be undertaken during the second phase of the project.

Price Flexibility and Output Effects of Money Supply Changes: Some Quantitative Estimates

RESEARCHER: ASSISTANT PROFESSOR HAREESH M. DHAWALE

SPONSOR: NAVAL ACADEMY INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE

The objective of this study is to obtain quantitative estimates of the impact of the degree of price flexibility on real output changes induced by changes in the money supply. Two small-scale macro-models—a flexible price macromodel and a macromodel with gradual price adjustment—were developed and estimated using data on the U.S. economy. The estimated models are being used to

simulate the effects on real output of changes in the money supply.

The models developed here will be used to provide midshipmen taking the Macroeconomics course hands on experience with the use of up-to-date macroeconomics models to address current policy issues.

Economic Geography and Limits to Growth Modeling

RESEARCHER: ASSOCIATE PROFESSOR ARTHUR GIBB, JR.

SPONSOR: NAVAL ACADEMY INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE

The objective of this project is to develop courseware for FE310, "World Economic Geography," of three types (1) documentation to make it possible for the students to use the Limits to Growth econometric model, (2) TV and AV materials to support common problem and testing sets, and (3) a related instructor's manual. This Economic Geography course serves as both the introductory international economics course and as a course in resource economics.

The limits to Growth model is a seven sector econometric model developed at the Massachusetts Institute of Technology in the 1960s. Three levels of new documentation are needed for the purposes of FE 310: first, a set to permit basic student access

to the model; second, a set of exercises for students interested in changing the assumptions/parameter values of the model; and, third, guidance for the sophisticated computer user interested in changing the structure of the model, especially with respect to the critical question of how technical change is handled in it.

By drawing on the Academy's educational resources as integrative tools, the project will improve and make more uniform the level of instruction in this multi-section, multi-instructor course. The manual will help make the new instructor immediately effective in the classroom and in addition will assure the optimal integration of the various course materials.

Estimation of Cost Functions of FED Payments Mechanism

RESEARCHER: ASSOCIATE PROFESSOR RAE JEAN B. GOODMAN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The Federal Reserve System (FED) has been involved in the payments mechanism since the creation of the System in 1914. Prior to 1980, the FED did not charge member banks for check clearing and electronic funds transfer (EFT); this was a service provided as a result of membership and of the holding of non-interest bearing reserves at the FED. In the Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMC), Congress provided that the FED must price the following services: currency and coin, check clearing and collection, wire transfer, automated clearinghouse (ACH), settlement services, securities safe-keeping, and FED float. In addition, Congress required the FED to provide the services to all financial institutions. This legislation put the FED into direct competition with private check clearinghouses, which have continued to exist in conjunction with the FED.

The first objective of the research project is to estimate the cost functions for check clearing and automated clearinghouse functions with the intent of improving the econometric approach to the prob-

lem. The second objective of this research is to provide a recent estimate of the cost function. This study will provide estimates through 1984.

A translog cost function was estimated for the automated clearinghouse function to ascertain whether the cost functions had changed over time and whether scale economics existed in the automated clearinghouse process. Both a simple and a more complex form of the cost function was estimated.

In the simple model, the coefficient (the scale economy measure) was less than one prior to FED pricing of services, and continued to be less than one well into the post-pricing era. A second interesting result is that the average total cost rose between the pre- and the post-pricing periods. Thus, while economies of scale exist, the model shows that the average total cost curve has shifted upward since the advent of pricing by the FED. One possible explanation for this is a shift in both the average cost curve and the demand curve in the post-pricing era.

Learning Curve Estimation in the Payments Mechanism

RESEARCHERS: ASSOCIATE PROFESSORS RAE JEAN B. GOODMAN AND THOMAS A. ZAK
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

Cost estimates for Federal Reserve (FED) check clearing, automated clearinghouses (ACH), and wire transfer services indicate: (1) average cost curves for check processing are U-shaped, demonstrating falling, constant, and rising costs as increasing volumes of checks are processed; (2) automated clearinghouses show declining average costs; and (3) wire transfer offices experience falling and constant average costs. Thus, scale diseconomies exist in check clearing and scale economies exist in automated clearinghouses. Therefore, private sector competition is useful in check clearing, but scale economies in ACH indicate lower costs for a single provider and imply excluding competitors.

Alternatively, decreasing average costs may arise from "learning by doing." The idea that plant effi-

ciency increases over time as workers gain skill through repetition has been recognized for some time. Research has shown that progress curves or learning curves occur in many different situations.

This research analyzes FED cost functions for check clearing and ACH to investigate the existence of "learning by doing" in these processes. The cost functions are examined over time to estimate any "learning by doing" phenomena in the automated clearinghouse process. Since ACH are a relatively recent innovation in the financial sector (they have been in existence only since 1972,) there is a distinct possibility that the observed decreasing costs are a result of learning rather than true long-run declining costs. This is an important distinction in formulating FED policy toward competition in this market.

Bringing Microcomputers to the Classroom III

RESEARCHERS: ASSOCIATE PROFESSOR RAE JEAN B. GOODMAN AND
ASSOCIATE PROFESSOR STEPHEN FRANTZICH (POLITICAL SCIENCE)

SPONSOR: NAVAL ACADEMY INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE

This project involves an application of microcomputers in the classroom: the development of simulations. Each simulation will begin with a list of learning goals. These goals will not necessarily be revealed to the students at the beginning except in the most general terms. The simulation will begin with the student being given a task and the context surrounding it. From this point, the student must select information to analyze to arrive at the answer. At various points along the decision-making process, the student will be given diagnostic statements on preceding choices. The student will then have the

option of "re-deciding." Once the student has made a series of decisions, the composite result will be presented. A diagnostic statement will specify where the student has made particularly good and particularly bad decisions. Because politics and economics are not exact sciences where consequences are completely predictable, some of the projections of consequence will have to be based on probabilities and assumptions. Where this is the case, students will be given the chance to explore the assumptions and alternatives.

Incentives and Internal Competition

RESEARCHER: VISITING PROFESSOR OLIVER R. GRAW

SPONSOR: NAVAL SUPPLY SYSTEMS COMMAND

The Naval Supply System has been and continues to be changed in fundamental ways. A variety of state-of-the-art technologies, including automated warehousing and process-controlled receiving, issuing, and transportation systems has been installed at various Naval Supply Centers. NAVSUP believes these new technologies will reduce inventory costs, reduce labor costs, and cut delivery time. In conjunction with the hardware, NAVSUP has also begun to implement productivity standards and, possibly, incentive-based compensation schemes. Economists have considered various incentive

schemes designed to elicit worker-specific information correctly and to induce optimal worker performance by appropriately assigning risks and sharing productivity gains. Moreover, productivity improvements leading to cost reductions may flow most efficiently when vertically integrated organizations (e.g., NAVSEA/NAVSUP) can induce internal competitions between parallel suppliers/customers. The present work involves using economic analysis to evaluate cost-saving methodologies established at Naval Supply Centers.

Military Veterans in Congress and Their Support Of National Defense and Veterans Legislation

RESEARCHERS: PROFESSOR ROGER D. LITTLE,
LIEUTENANT COMMANDER RAYMOND F. TURNER, USNR, AND
PROFESSOR JOHN A. FITZGERALD (POLITICAL SCIENCE)
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

Voting analysis literature identifies two primary explanations of voting behavior: ideological preference and constituent interest. Recently, social scientists have published several papers on ideological preference and its manifestation in the public choice decisions by legislative bodies. Some work has also focused on *changing* constituent interest as a determinant of *changing* legislative voting patterns. This research primarily addresses the question of how the expected *change* in the ideological composition of Congress will affect its willingness to support national defense, but also will draw on a constituent interest approach in order to determine whether cultivation of such interests constitutes a viable alternative, should the ideological support for national defense dissipate.

It is hypothesized that legislators with military experience constitute an ideological voting block

with a predisposition to support national defense interests when compared to their colleagues without military experience. Because of the deterrent policies used during the Vietnam War and the subsequent advent of the all-volunteer force, it is self-evident that the number of Congressmen with military experience will diminish markedly between now and the end of the century. This fact may have significant effects on support for defense issues.

The initial thrust of the research is to determine the extent to which veterans in the Congress constitute an ideological force in support of defense issues. Presuming that such influence exists, the political and economic balance with respect to public choice between defense and non-defense appropriations may realign, as fewer members of Congress share the common background of being veterans.



Cost-Benefit Analysis of Personnel Security

RESEARCHERS: PROFESSOR ROGER D. LITTLE,
ASSOCIATE PROFESSOR THOMAS A. ZAK, AND
PROFESSOR JOHN A. FITZGERALD (POLITICAL SCIENCE)
SPONSOR: NAVAL POSTGRADUATE SCHOOL

Theory of the economics of information argues that information should be gathered, optimally, until the expected costs of gathering the information exceed the expected benefits. There appear to be two approaches, or two levels, to information gathering in the analysis of personnel security. On the macro level, the question involves the optimal amount of security leaks and their time phasing. That is, what is to be protected, how well is it to be protected, and when is protection to be relaxed? On the micro level, the question becomes how to minimize the number of inadvertent security leaks to systems which have been chosen for protection. The problem thus becomes a behavioral one, focusing on the cost of gathering more and different kinds of information on individuals. That is, how are people chosen to act as guardians of what has been chosen for protection?

Since one does not know exactly what information is at risk, and if leaked information will be found valuable to one's rivals, a cost effective pro-

gram will almost certainly be stochastic (i.e., intermittent surveillance, or random checks, both through time and across individuals) in that all of the information must be put in *expected cost* and *expected benefit* terms. The problem is that the underlying probabilities of leaking, detection, and value to rivals are unknown. One not only must make point estimates of benefits and costs, but also provide confidence intervals as well, while recognizing that value changes with time in some instances. Estimating the probability distributions of outcomes is a very difficult task, but may be necessary, because one may wish to accept a higher mean level of leaks if it is accompanied by less risk of a catastrophic leak. In sum, it is likely that decision makers do not have a single-valued utility function, but one which depends on the expected mean level of leaks, the expected variation about the mean, the cost of prevention program, and the agency's other outputs.



Navy Enlistment Supply: A Switching Regression Approach

RESEARCHER: VISITING PROFESSOR JOHN T. WARNER

SPONSOR: CHIEF OF NAVAL RESEARCH (OP-01)

Since the work of the Gates Commission in 1970, there have been many studies of the factors that determine enlistments into military service. Explanatory variables considered in these studies include relative military pay, civilian unemployment, youth population and its composition, recruiting resources, including military recruiters and advertising expenditures, and educational programs like the G.I. Bill. One problem with most of these studies that has begun to receive recent attention is that they treat enlistments as strictly supply-determined and do not recognize that the military's demand for personnel, measured by recruiting goals, can have significant effects on observed enlistments. Failure to incorporate goals into the enlistment supply model can lead to mismeasured effects of the determinants of supply.

Accordingly, this study sought to determine whether demand factors should be incorporated into Navy enlistment supply models. Using readily available data from an earlier study covering the period 1976-1980, incorporating goals into the model was found to have important effects on supply and on estimates of the other determinants of supply.

This preliminary analysis indicated the importance of incorporating demand-side factors into enlistment supply models. Because there have been many changes in the recruiting environment since 1980, however, it is essential that enlistment supply models be based on more recent data. To provide that basis, quarterly data on enlistments into all four services for the period 1981-1986 were collected and are being analyzed. In addition to providing a re-examination of the effects of recruiting goals and other variables on enlistment supply, the study will examine a very important issue - whether there exists interservice competition or complementarity in recruiting. In the last several years, the Army has experienced a very sizeable increase in recruiting resources and educational incentives relative to the Navy. The study will estimate whether this increase has adversely affected Navy enlistments (the interservice competition hypothesis) or in fact led to an increase in Navy enlistments (the complementarity hypothesis).

Labor Force Partitions and Earnings of Navy Wives

RESEARCHER: VISITING PROFESSOR JOHN T. WARNER,

PROFESSOR ROGER D. LITTLE, AND

ASSOCIATE PROFESSOR THOMAS A. ZAK

SPONSOR: CHIEF OF NAVAL RESEARCH (OP-01)

Very little is known about the employment and earnings of Navy wives and how these variables are affected by factors such as family separation resulting from sea duty and permanent change of station moves. Further, little is known concerning the potential link between spouse employment considerations and members' retention decisions. Yet, given the high percentage of today's force that is married and the increasing weight that families in today's society are giving to spouses' employment, information on these questions is vital to Navy policymakers.

Luckily, a data base that will allow researchers

to address these questions has recently become available, the 1985 DOD Personnel Survey. This survey contains detailed information on over 120,000 military members and 30,000 spouses in all four services. This work involves analyzing these data with the objective of addressing the questions pertaining to spouse employment and earnings and the effect of permanent change of station moves on the time required for wives to find jobs at their new locations and the types of jobs they acquire. Answers to these questions will help the Navy formulate more effective programs of spouse employment and job search assistance.

Accounting Software for Use With an Existing Database-Spreadsheet Package

RESEARCHER: ASSOCIATE PROFESSOR ROYALL A. WHITAKER

SPONSOR: NAVAL ACADEMY INSTRUCTIONAL DEVELOPMENT ADVISORY COMMITTEE

As a result of this work, students can journalize transaction and adjusting entries (a process which *always* involves analysis) with help in the form of prompts, error statements, and a current balance sheet, thus learning some mechanics and also doing realistically large problems in reasonable amounts of time. Posting to accounts is done

automatically and closing and statement-preparation will at first be done automatically. Thought and judgement are required in these steps, but accounting students are mostly upper-classmen who will not yet have the spreadsheet package for which the software is designed and therefore cannot exploit its flexibility.



Independent Research

Net Impact Evaluations of Joint Training And Partnership Act-Title III Demonstration Program

RESEARCHER: ASSOCIATE PROFESSOR WILLIAM R. BOWMAN

This report evaluates the major large-scale employment and training demonstration programs funded by the U.S. Department of Labor for workers who lost their jobs due to plant closings or permanent mass layoffs. Workers eligible for such assistance receive employment search assistance, and if needed, retraining assistance under the dislocated worker program of Title III of the Joint Training and Partnership Act (JTPA)—the country's largest employment and training program.

The report summarizes the quantitative findings of three delivery agents—Detroit Downriver Community, Buffalo Private Industry Council, and Texas Economic and Community Development—which operated six different programs in these areas over the last five years.

The major findings conclude that all programs yielded net positive benefits, as measured by the in-

crease in employment duration and average earnings, over that expected had program participants not enrolled in the Title III JTPA programs. The range of benefits varied widely across all six programs, with the largest benefits accruing to white males with long job tenure. The programs had little if any impact on reduction in public assistance programs. The most cost-effective form of assistance appeared to be low-cost job search workshops as compared with more expensive classroom and on-the-job retraining programs.

The final report was used by the U.S. Department of Labor's Task Force on Economic Adjustment and Plant Closings, which initiated administrative and Congressional action to support an enlarged program for dislocated workers in the FY 1988 federal budget.

Adjustment Costs, Specific Human Capital and Business Cycles

RESEARCHER: ASSISTANT PROFESSOR HAREESH M. DHAWALE

The researcher investigated the serial correlation properties of output and employment in the context of an adjustment cost model derived from Specific Human Capital (SHC) considerations. Although adjustment cost models have been employed in the new classical equilibrium approach to explain the observed positive serial correlation in employ-

ment and output over the course of the business cycle, the SHC model developed here can at best explain *only* the positive serial correlation in *output* during the *initial* stages of the upswing and downswing. The SHC model's ability to explain the positive serial correlation in employment is found to be even more limited.

The Links Between the Private Sector and Low Resource Agriculture in Sub-Saharan Africa

RESEARCHER: ASSOCIATE PROFESSOR ARTHUR GIBB, JR.

This paper is one of fourteen contracted by the Office of Technology Assessment to provide the bases for a report to Congress, "Low-Resource Agriculture in Developing Countries: Implications for Africa." The objective of the research is to describe and explain – based on evidence from Asia as well as Africa – the links between non-agricultural activities and low-resource agriculture and then to identify points of intervention whereby public policy might

induce more rapid rates of agricultural growth and welfare. The particular focus is on ways to maximize the participation of private enterprise in this process. The research utilizes structural transformation theory and methods of employment and spatial analysis developed by the researcher to integrate otherwise disparate and fragmentary evidence on these rural-urban linkages.

Regulation and Productivity

RESEARCHER: VISITING PROFESSOR OLIVER R. GRAWE

Using time series data from various sources, it can be shown that both total factor productivity and output per manhour have tended to rise more rapidly in regulated industries generally than in non-regulated industries during the entire post World War II period. This fact has apparently gone without comment. This silence is surprising, since many economists have concluded that government regulation worsens economic performance in a variety of ways. Several explanations may account for the positive observed regulated non-regulated

productivity differential. First, the differential may be largely spurious, arising from price effects rather than reductions in real resource use per unit of output. Second, regulated industries may have differentially benefitted from technical changes (e.g., jet airframe and engine designs) arising outside the regulated industries. Third, regulation may act to enforce property rights by limiting entry and, hence, imitation of successful cost-reducing investments undertaken by incumbents. The present work seeks to differentiate empirically among these alternatives.

Value of Information on Health Risks: The Case of Indoor Radon

RESEARCHER: ASSOCIATE PROFESSOR F. REED JOHNSON

Because of the nature of the radon problem and the relatively weak statutory authority to regulate indoor air pollution, the Environmental Protection Agency (EPA) has decided to rely on voluntary measures to reduce radon exposures. The agency will promote voluntary mitigation by means of information programs to assist homeowners in interpreting radon test results, assessing personal health risks, and identifying cost-effective house structure modifications to reduce radon concentrations. The effectiveness of such a policy depends critically on the ability of homeowners to assess risks accurately and respond rationally to the tradeoff between economic costs and increased life expectancy.

The New York Energy Research and Develop-

ment Authority has tested 2500 homes for indoor radon. This program provides an opportunity to observe a natural experiment on the formation of risk perceptions and subsequent mitigating behavior. This project will develop information materials to be sent to each household, and survey households over a one-year period to assess the effectiveness of alternative information formats and to estimate the value of reduced health risks based on the observed behavior of participating homeowners.

The first phase report is now being written. One manuscript from this study has been published and one has been accepted for publication subject to revisions. Additional manuscripts will be submitted based on chapters in the report.

The Socioeconomic Status of Black Veterans

RESEARCHER: PROFESSOR ROGER D. LITTLE

This paper reviews the existing evidence on the socioeconomic status of Black veterans. The review finds unequivocal evidence that both Black and white World War II veterans have higher socioeconomic status than their nonveteran counterparts. The keys to the higher status of both groups is more education, and the ability to convert that education into higher earnings. Apparently, much the same conclusion can be made concerning Korean War veterans, but to lesser extent. Vietnam veterans now have had sufficient time for their post-service education, if it is to benefit them, to begin showing a pay-off. Thus, research on the life cycle earnings of these veterans now can meaningfully be carried out. Shorter run research, that is, research through the late 70s, shows little earnings benefit to the military service, of these veterans. However, for the entire veteran cohort to reach an earnings "crossover," 15

to 20 years may be necessary. That time is now. Some studies in progress surely will add to our understanding of these veterans' experiences, but unfortunately the existing longitudinal micro-data bases which could best address the Vietnam cohort are neither well timed nor well designed to allow air-tight conclusions.

Earlier research clearly suggests the policy variable which would be most useful in enhancing the socioeconomic status of both Black and white veterans is post-service educational benefits. But, before jumping on the G.I. bill bandwagon, it would be useful to know whether the post-service education would be acquired by veterans even without the G.I. Bill incentive and whether such education continues to provide a significant enhancement to socioeconomic status at a time when nearly all veterans will have high school diplomas.

Explanations of Racial Difference in School Suspensions

RESEARCHERS: PROFESSOR ROGER D. LITTLE AND
PROFESSOR JOHN A. FITZGERALD (POLITICAL SCIENCE)

This work explores reasons for racial differences in school suspensions and expulsions using data from the National Longitudinal Survey, 1979. The evidence, at this point, seems to suggest that the differences are due to lower socioeconomic status

among blacks and their lower verbal scores on standardized tests. Holding these variables constant, along with other delinquency attributes of the individuals, suggests that blacks are not suspended on racial grounds, *per se*.

Research Course Projects

Estimation Techniques for Valuing Non-Market Goods

RESEARCHER: MIDSHIPMAN 1 C EDWARD D. HOLLAND

ADVISER: ASSOCIATE PROFESSOR E. REED JOHNSON

The purpose of this research was to review and evaluate the various benefits of estimation techniques employed for non-traditional markets. In the traditional market, the value of goods, excluding externalities, may be derived from the market price. When no well-organized market exists, as is the case for many environmental amenities, economic costs and benefits have often been ignored. Economists have developed and refined three different ap-

proaches for estimating nonmarket values: the travel cost method, the contingent valuation method, and the hedonic method. Each method has advantages and disadvantages depending on the characteristics of the goods involved, the availability of data, and the use of which the values will be put. This research reviewed the literature for each method and evaluated the relevance of each method for a variety of applications.

Effects of Alternate Modes of Financial Information: An Experiment in Social Science Research

RESEARCHER: MIDSHIPMAN 1 C JOHN C. KENNEDY

ADVISER: COMMANDER CHARLES A. PERKINS, SC, USN

A social science statistical study of fourth class midshipmen's knowledge of personal financial information was conducted, together with a study of alternative methods of improving this knowledge. A preliminary questionnaire was administered to one company of Plebes to determine those financial subjects in which they were most interested. The most frequently mentioned topics were researched, and two information packages were developed. The first consisted of facts and clearly written information on the subjects. The second package was augmented with drawings and cartoons. Six Companies were

selected for study. Two were presented no information; two received the first (factual) package; and two received the second (augmented) package. A test questionnaire was administered to examine the Plebes' knowledge. The null hypothesis was that there would be no difference in performance among the three groups. The results suggested rejection of the null hypothesis but did not adequately account for alternative causation. The methodology was re-examined to determine how the problem might better be approached.

Publications

BOWMAN, William R., Associate Professor, "How College Graduates Find Good Jobs," *Employment and Career Counseling Journal* (Winter 1987), 32-36.

The research article is an empirical analysis of the impact of job search techniques on the quality of entry-level jobs for a large representative sample of Maryland college graduates of the class of 1984.

The quality of jobs is measured by initial annual salary and how closely related are skills used on the job to those perceived to have been developed during one's college experience. The study controls for the academic major chosen, sex, and age, and estimates the impacts on entry-level job quality of method of job search responsible for obtaining the job, and of the duration of successful job searches.

The study shows that, regardless of academic major chosen, job search techniques are significantly related to the quality of entry-level jobs found. While college placement offices account for only one in twenty jobs found, the quality of those entry-level jobs are superior with respect to starting salaries and the degree to which skills acquired in college are related to those used in the work environment. Jobs found in the "hidden market" of personal contacts and direct applications, which account for nearly two out of three jobs, result in either high salaries (personal contacts) or in skills closely related to that acquired while in college (direct applications).

The timing of job search is found to be very critical to the quality of jobs found as well. Only

one in three jobs is found before graduation. However, these jobs are significantly better, regardless of the method used in locating entry-level positions. Jobs found following graduation, as well as jobs taken with a firm that employed the graduate on a full- or part-time basis prior to graduation, tend to be interior entry positions.

The study results are the first empirical findings available for supporting college career counseling efforts to get students into an active job search prior to graduation.

GIBB, Arthur, Jr., Associate Professor, "World Economic Geography: Meeting the Needs of Today's Undergraduates," *Journal of Geography*, 86, 3 (May/June 1987), 90-91.

This paper reports the conclusions of a series of panels and workshops sponsored by the World Economic Geography Working Group of the Association of American Geographers (AAG) over the past three years. The notable conclusions are (1) that economic geography is taught two different ways which had better be titled, respectively, as "world economic geography" and "economic geography and spatial analysis;" (2) that there is an identifiable core content common to most treatments of the former, and four different variants can be identified depending on whether trade, development, multinational enterprise, or urbanization is emphasized. The paper also suggests that economic geography offerings can be made more coherent and articulate in the way they are presented to other academic departments.

GOODMAN, Rae Jean B., Associate Professor, Oliver R. GRAWE, Visiting Professor, and Thomas A. ZAK, Associate Professor, "The Federal Reserve System's Role in Electronic Funds Transfer Provision," R. Rogowsky and B. Yandel, eds., *Regulations and Competitive Strategy*. Lanham, Maryland: University Press of America, 1987.

This work sets out a framework for discussing public provision of services generally, with special attention to the Federal Reserve System's (FED) electronic funds transfer (EFT) payments clearing activity.

The central discussion in the paper concerns the general theory of public provision of services. Special attention is paid to the role of the FED in the EFT market. The issue of cross-subsidization and generalized subsidy of services used by firms subject to regulation is discussed. The model developed presumes the regulator/provider maximizes bureaucratic or organization slack. As a result, it is shown that such an enterprise has an independent, internal incentive to enter otherwise competitive markets, and potentially, to supply services at less than marginal cost. This conclusion does not rely on typical voting or public choice-related arguments holding that political forces induce redistribution to favored supports by altering relative prices. Apparent commercial bank resistance to FED EFT provision is examined in the context of alleged service subsidization by the FED.

A later section of the paper sets out various alternative explanations for the FED's present role as both a regulator and supplier of EFT (and check clearing) services. These motives include system security, minimization of commercial risk of system failure, economies of scale, promotional pricing, and the connection between payments mechanisms and the proper control of monetary aggregates.

GOODMAN, Rae Jean B., Associate Professor, "The Proposed Conference Committee Tax Bill," *An Analysis of the Proposed Capital Requirements for Thrift Institutions: A Staff Economic Study*, Office of Policy and Economic Research, Federal Home Loan Bank Board, August 1986.

An important determinant of the ability of the thrift industry to satisfy the proposed capital requirements is the taxation of the industry's net income. Retained earnings, used to build equity, are taken from after-tax income. The after-tax profitability of the industry also influences the extent to which additional

equity can be raised in the capital markets. Furthermore, provisions in the tax code can affect the before-tax income of the industry. Therefore, the revisions in the tax code currently being finalized will likely have important implications for the ability of the industry to meet the proposed capital requirements.

Provisions of H.R. 3838 as reported by the Conference Committee directly affect the taxation of savings institutions by changes in: the corporate tax rates, the contributions to the bad-debt reserve, the minimum tax, the operating-loss deductions, the dividends-received deduction, and the investment tax credit. The Conference Committee Bill indirectly affects savings institutions by: the changes in depreciation; the limitation on deductions for losses on rental real estate; the limitation on loan interest deductibility for individuals; the reduction in individual income tax rates; the elimination of the special treatment of capital gain; and the introduction of the low income rental housing tax credit.

Subsection A describes the Conference Committee proposed changes in corporate tax rates, bad debt deductions, and the minimum tax. The current law for each of these areas is presented, followed by a descriptions of the changes. Subsection B presents an analysis of the effect of the three changes on thrifts' taxes. Subsection C examines the effect of the extension of loss carry forwards. Subsection D evaluates the effect of the elimination of the investment tax credit and the reduction in the dividends-received deduction.

GOODMAN, Rae Jean B., Associate Professor, "The New Tax Law Gives Thrifts a Break," *Outlook of the Federal Home Loan Bank System*, January/February 1987, pp. 7-10.

This article outlines the changes of the Tax Reform Act of 1986 and how these changes will affect thrift institutions. In general, the outcome of tax reform should prove positive—especially if an institution is large, generates good profits, and has a wealth of carryover losses from the first half of the 1980s. While the net demand for mortgages may decrease, thrifts will be able to enter into markets opened to them by the Depository Institutions Deregulation and Monetary Control Act of 1982. Thrifts will be in a better position to meet capital requirements and the demands issuing from the recapitalization of the Federal Savings and Loan Insurance Corporation.

JOHNSON, E. Reed, Associate Professor, co-author, "Radon Risk Information and Voluntary Protection: Evidence from a Natural Experiment," *Risk Analysis*, 7, 1 (March 1987), 97-107.

This study examines the perceived risks and mitigating behavior of Maine householders who received new information on their exposures to significant health risks from indoor radon. The observed responses of these people illustrate conceptual issues related to designing an effective risk information program. Despite the involvement of generally well-motivated homeowners and well-intentioned researchers and government officials, the researcher concludes that the risk information approach used in Maine failed to induce appropriate, cost-effective voluntary protection. The results indicate that, after receiving radon test results, information on associated health risks, and suggestions on how to reduce exposures: (1) perceived risks tended to understate objective risks by orders of magnitude, and (2) there was no statistically significant relationship between mitigating behavior and objective risks. These results suggest that the information of risk perceptions and subsequent behavioral adjustments involve complex interactions among information, contextual, socio-economic, and psychological variables. Therefore, government programs that seek to reduce health and safety risks with information programs instead of using more conventional enforced standards must be crafted very carefully to accommodate this complex process.

WARNER, John T., Visiting Professor, co-author, "Military Experience, Civilian Experience, and the Earnings of Veterans," *Journal of Human Resources*, 22, 1 (Winter 1987), 62-81.

This paper examines the effects of military experience and civilian experience on the earnings of veterans, with the objective of determining the substitutability of these two forms of training for personnel receiving different types of military training. To perform the analysis, the Social Security earnings record of 24,000 individuals who separated in fiscal year 1971 were obtained for the period 1972-77. Analysis of these data reveals that more military experience does increase subsequent civilian earnings, but that the relative impact of military and civilian experience varies considerably by military occupation category.

WARNER, John T., Visiting Professor, co-author, "Explaining Differences in State Growth: Catching Up Versus Olsen," *Public Choice*, 52, 2 (1987), 201-213.

Explaining differences in rates of economic growth has been one of the main tasks of economics since before the time of Adam Smith. This paper analyzes economic growth rates in the 50 U.S. states since 1929, with the objective of testing two competing hypotheses for why growth rates vary across states: the catching-up hypothesis and Mancur Olsen's "institutional sclerosis" hypothesis. Several tests of these hypotheses are performed, and the results unequivocally support the catching-up hypothesis.

Presentations

AUSTIN, Michael G., Lieutenant, USNR, SC, "The Complications Associated with an Integrated Office Automation System Life Cycle Analysis," 1987 Institute of Cost Analysis National Education Symposium, St. Louis, Missouri, 21-22 April 1987.

BOWMAN, William R., Associate Professor, "Comparisons of Dislocated Worker Programs in the United States and West Germany," Atlantic International Economic Meetings, Munich, German, 27 April 1987.

GIBB, Arthur R., Associate Professor, "Rural Growth Linkages in Sub-Saharan Africa," Meeting of the Association of American Geographers, Middle States Division, New York, New York, 18 October 1986.

GIBB, Arthur R., Associate Professor, "General Education in the Information Age: The Role of Foundation Courses in Today's Undergraduate Curriculum," Annual Meeting of the Association of American Geographers, Portland, Oregon, 23 April 1987.

GRAWE, Oliver R., Visiting Professor, "Issues in the Economics of Defense Acquisition," Conference on Economics of Defense Acquisition, U.S. Naval Academy, Annapolis, Maryland, 2 June 1987.

GRAWE, Oliver R., Visiting Professor, and Thomas A. ZAK, Associate Professor, "Surge Capacity and Industrial Mobilization: Notes on the Relationship Between Current and Future Output," Industrial College of the Armed Forces Conference on Marshaling Resources for Conflict Short of Declared War, Washington, DC, 16 April 1987.

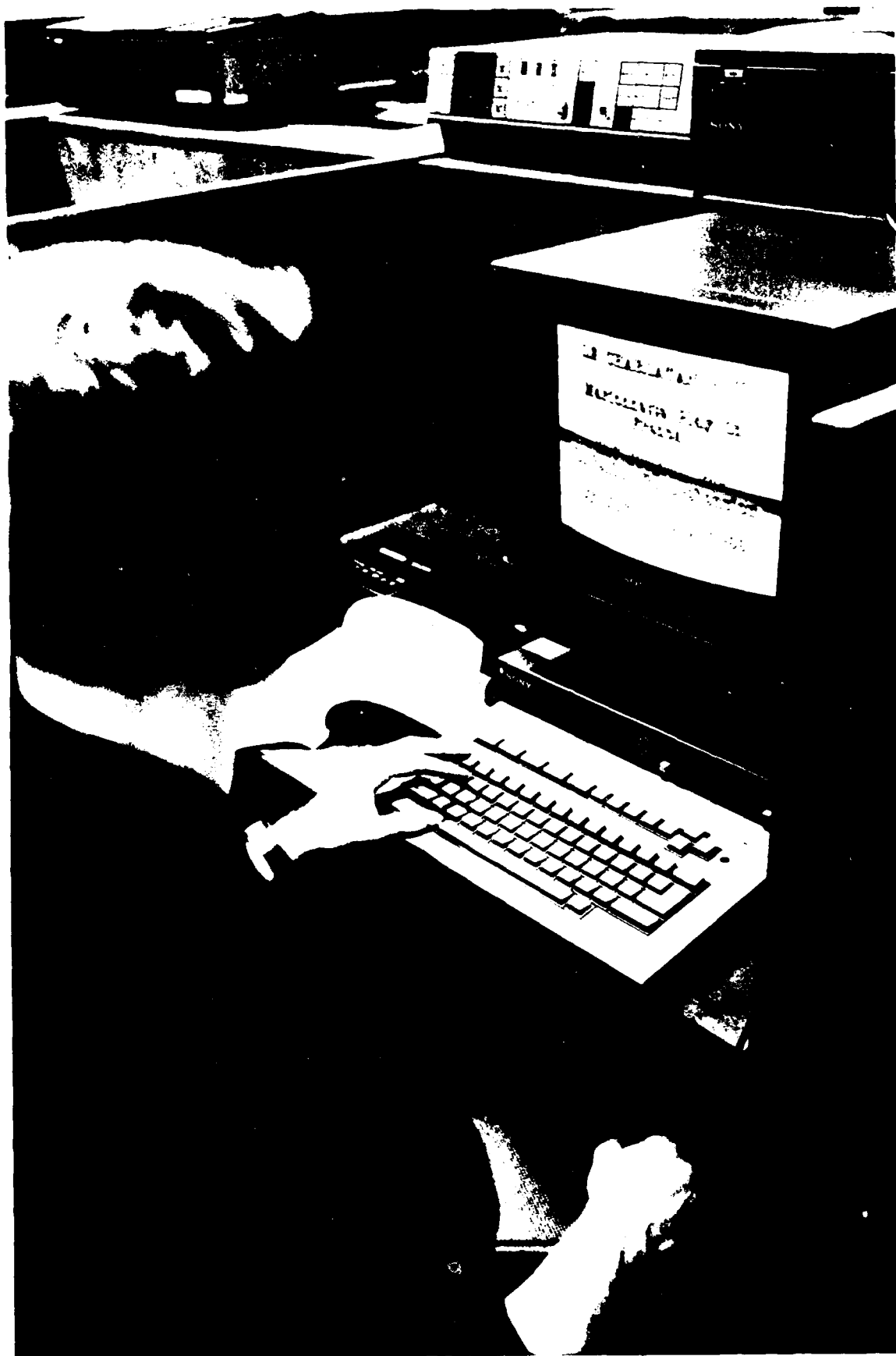
JOHNSON, F. REED, Associate Professor, "The Effect of Radon Risk Information on Mitigating Behavior," Environmental Law Institute, Washington, DC, 24 July 1986.

JOHNSON, F. REED, Associate Professor, "Signal Detection and Perceived Risks: Homeowner Responses to Radon Risk Information," U.S. Environmental Protection Agency, Washington, DC, 3 December 1986.

JOHNSON, F. REED, Associate Professor, "The Economic Benefits of Reducing Exposures to Indoor Radon," U.S. Environmental Protection Agency, Washington, DC, 6 May 1987.

LITTLE, Roger D., Professor, "The Socioeconomic Status of Black Veterans," Roundtable on Post-Service Experiences, Joint Center for Political Studies, Washington, DC, 19 June 1986.

WARNER, John T., Visiting Professor, "A Switching Regression Model of Navy Enlistment Supply," Center for Naval Analyses, Alexandria, Virginia, 18 March 1987.



DEPARTMENT OF

Language Studies

PROFESSOR MICHAEL C. HALBIG
CHAIRMAN

Faculty research efforts in the Language Studies Department remained strong during the academic year just completed. The Department received the largest single research grant ever awarded a USNA department: a DOD grant of \$1.1 million to develop and evaluate interactive video applications for the foreign language classroom. As a result of efforts in this area dating back to 1985, the Department is now one of the leading institutions in exploiting this important new resource. Members of the Department also made major contributions towards acquiring a multi-million dollar 40-foot x-y satellite tracking station, an important research tool for several USNA disciplines. Several members of the Department completed book-length projects for publication. And nearly everyone of the civilian faculty made at least one conference presentation.



Sponsored Research

The Modernisms of Gyorgy Lukacs

RESEARCHER: ASSOCIATE PROFESSOR EVA L. CORRIDOR
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The manuscript consists of ten essays which are meant to demonstrate the relevance of Gyorgy Lukacs's views for the complex discourse of contemporary literary theory and criticism. Each chapter confronts one major aspect of Lukacs's theories, such as the genre of the epic in relation to the novel,

the rule of the intellectual, historicism, or a comparison of Lukacs's theories to those of other important theoreticians such as Michael Bakhtin, Michel Foucault, Lucien Goldmann, Fredric Jameson, and Jacques Leenhardt.

A Different France: Studies of the Diverse Heritage of France's Regions

RESEARCHER: ASSISTANT PROFESSOR AUDREY GAQUIN
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This project is a collection of documents concerning the seven regions of France which have a non-French linguistic and cultural heritage: Alsace, Brittany, Corsica, Flanders, North Catalonia, Occitania, and Pays Basque. The documents will include interviews of cultural leaders in these regions, sample lessons in the regional languages, and articles on the

history, traditions, and culture of each region. The text will also include an introduction to each region for non-specialists. Some topics addressed will be the current federalist movement in France, the Arthurian tradition in Breton art and literature, and Cathar heritage in Occitania, and the identity problem of the people of Alsace.

The Correspondence of Luis Alberto Sanchez

RESEARCHER: ASSISTANT PROFESSOR ELSA M. GILMORE
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The purpose of this project is to produce an organic edition of the correspondence of Luis Alberto Sanchez, a well-known Peruvian writer and scholar, one of the founders of Peru's Apra party, and currently his nation's first vice president. Among Dr. Sanchez's correspondents have been some of Latin America's literary and political luminaries, including Pablo Neruda and Gabriela Mistral. The thread that joins

well-known names and events often runs through Sanchez's archives. Microfilms of his letters will be examined, organized, and transcribed, and Dr. Sanchez will be interviewed concerning the significance of his correspondence. In addition, Dr. Sanchez has agreed to supply the researcher with records of letters not included in the archives which he donated to the Pennsylvania State University.

Annapolis Interactive Video Project

RESEARCHERS: ASSOCIATE PROFESSOR GLADYS RIVERA-LA SCALA (PROJECT DIRECTOR),

ASSISTANT PROFESSOR CHRISTOPHER BUCK,

ASSOCIATE PROFESSOR SHARON DAHLGREN, ASSISTANT PROFESSOR

WILLIAM FLETCHER, PROFESSOR JOHN HUTCHINS, ASSISTANT PROFESSOR

ENRIQUE MARQUEZ, AND PROFESSOR JOHN YARBRO

SPONSOR: DEPARTMENT OF DEFENSE, NATIONAL SECURITY AGENCY

Under Professor Rivera-La Scala's direction, a seven-member team set up criteria for evaluating hardware and software for interactive video lessons and work stations, and made hardware and software selections. Members of the team selected and edited fifty-eight Spanish language sequences and created master lesson designs and modules and an authoring system which will permit implementation of these designs. Information concerning the project was shared with the U.S. Military Academy, the Air Force Academy, the Central Intelligence Agency, the National Security Agency, the Defense Language Institute, Colum-

bia University, the University of Pennsylvania, and the University of Michigan. Presentations on the project were given at the Computer-Assisted Language Learning and Instruction Consortium Symposium and at the Georgetown University Round Table on Languages and Linguistics. In the Fall of 1987, seventy to eighty students in first-year Spanish courses at the Academy will begin using interactive video lessons to practice listening comprehension and reading comprehension skills, and the team will begin evaluation of interactive video technology as applied to foreign language education.



Independent Research

Semiotics and Calderon

RESEARCHER: ASSOCIATE PROFESSOR SHARON G. DAHLGREN

This book-length study combines the methodology of the semiotics of theater with historical research on Pedro Calderon's secular drama of seventeenth-century Spain. In an attempt to develop a pragmatic semiotic model for the analysis of dramatic art, the researcher has identified two complementary levels, the microsign that takes into account sign typology, such as Charles S. Peirce's icon, index, and symbol, and the macrosign that refers to larger systematic constructs that are responsible for the overall dramatic frame of a given play. Areas of inquiry that

this study addresses are the function of sibling relationships in Calderon as they control and guide the dynamics of plot structure, the most notable of which are twin relationships, the feminine perspective in Calderonian female adjuvants, or assistants to principal male figures, Calderonian tragic models, and finally performance codes, with an analysis of specific twentieth-century performances recorded on videotape. The objective of this study in semiotics is to reach a better understanding of dramatic sign systems in Golden Age Spain.

Semantic and Pragmatic Factors in the Use of Dutch Gender Forms

RESEARCHER: ASSISTANT PROFESSOR WILLIAM H. FLETCHER

This project is an investigation into the extensive restructuring of the gender systems of Dutch along semantic lines. Data obtained from a statistical study of gender form use in various corpora of spoken Dutch support the researcher's hypothesis that pronoun reference in Dutch is primarily controlled by the semantics of the referent, not the lex-

cal gender of a noun antecedent. Current work has concentrated on expanding the statistical data base on usage of gender forms, studying the acquisition of lexical and semantic gender by Dutch children, and further integrating the researcher's observations and hypotheses into the form-content analysis' theoretical framework.

Italian and Spanish Epic Poems of the Sixteenth Century

RESEARCHER: ASSISTANT PROFESSOR RITA P. LANDERS

The purpose of this research is to expand on the area of Professor Landers' doctoral dissertation. She has completed one article ("Dialectica neoplatonica entra amante y amade en 'Las lagrimas de Angelica' de Barahona de Soto") to be published in Italy. Professor Landers is presently working on a second article ("Imitacion creadora y creatividad imitadora: un eslabon significativo en el tratamiento de un mito

clasico favorecido") to be presented in October 1987 at the Mountain Interstate Foreign Language Conference in Richmond, Virginia. Both articles focus on the Renaissance theories of love used by the Spanish poet, Barahona de Soto, taken from classical poetry as well as from the authors Loen Hebreo and Baldassar Castiglione.

Automated Biographic Analysis of the Chinese Military Leadership

RESEARCHER: PROFESSOR DANIEL T. Y. LEE

This is a continuing long-range project to study biographic characteristics and career patterns of significant military leaders in the People's Republic of China. It employs English-text summaries prepared according to strict syntactical rules with embedded computer flags permitting the computer to search biographies and develop summaries by char-

acteristics, or to link logically different leaders as they progress through their careers. As data accumulate, it is expected that hierarchical clustering techniques will establish patterns of ascendancy.

The total number of biographies included now stands slightly over one thousand, and about five hundred previous entries have been updated.

Conciliation and Refutation in Fidel Castro's Speeches on China (1962-1968)

RESEARCHER: ASSISTANT PROFESSOR ENRIQUE MARQUEZ

This research is focused on Fidel Castro's rhetoric. Its purpose is to study the topical arrangements in his foreign affairs speeches concerning his dual ideological alignment vis-a-vis China and the USSR. Chronologically, this stage of Castro's rhetoric is described as one of promulgation and polarization.

The specific *topoi* (in Aristotle's sense) of conciliation and refutation are retraced through the

argumentative orientation and scheme of the speeches. The theoretical frame of this study is that of Austin's theory of *speech acts*, and O. Ducrot and J. C. Anscombe's theory of argumentation.

This research is to be presented as a doctoral dissertation at the Ecole des Hautes Etudes en Sciences Sociales de Paris, France.



Research Course Projects

A Comparative Study of Modern Chinese History

RESEARCHER: MIDSHIPMAN 1/C RICHARD J. CHAO

ADVISER: PROFESSOR DANIEL T. Y. LEE

The project was essentially a continuing effort to develop a command of the Chinese language adequate for first-hand understanding of Chinese materials as a basis for research in the field of contemporary Chinese studies. Key areas were: (1) textbooks on modern China published in the People's Republic of China and Taiwan from the period of 1940 to 1945, and (2) publications on China's War

of Resistance against Japan, 1937-1945. The purpose of the research was to compare the views held by Beijing and Taipei on their respective roles in the eight-year war with Japan.

The final, lengthy report, written in Chinese, included a compilation of findings as well as commentaries.

A Critical Study of *Romance of the Three Kingdoms*

RESEARCHER: MIDSHIPMAN 1/C RICHARD J. CHAO

ADVISER: PROFESSOR DANIEL T. Y. LEE

The purpose of this research was to study a famous Chinese novel, *Romance of the Three Kingdoms* (221-263 A.D.) to further the researcher's interest and ability in the study of the Chinese language and thus broaden his work in his Political Science major with an Asian Studies concentration.

Oral reports in Chinese were a regular part of the course, followed by content discussions between the researcher and his adviser on the cultural and political climate of that period. A written report emphasizing key personalities of the Three Kingdoms was submitted at the end of the semester.



Publications

CORREDOR, Eva L., Assistant Professor, *Gyorgy Lukacs and the Literary Pretext*. New York and Bern: Peter Lang, Winter 1987.

The book is an introduction to those works of Gyorgy Lukacs that have established him as a classic authority in literary criticism: *The History of the Evolution of Modern Drama* (1911), still not available in English, which is analyzed in the original Hungarian text and from which extensive quotations are provided in English; the collection of Kantian essays, *Soul and Form* (1910); the Hegelian *Theory of the Novel* (1920); and Lukacs's first Marxist work, *History and Class Consciousness* (1923), which best characterizes the Hungarian philosopher's problematic position between East and West. Lukacs's Marxist literary theories are studied in the texts written during his exile in Stalinist Russia but published much later: *Studies in European Realism* (1950), *The Historical Novel* (1955), and *Realism in our Time* (1957). The approach to Lukacs's work is both selective and global. On the one hand, Lukacs's theories are introduced with a focus on his views on French literature. On the other hand, these theories are integrated in the totality of Lukacs's intellectual development. At each phase, the true motive of Lukacs's interest in literature presents itself as a pretext to the study of reality.

CORREDOR, Eva L., Assistant Professor, co-author, *Tracing Literary Theory*, ed. Joseph Natoli. Urbana: University of Illinois Press, Summer 1987.

Intended for both undergraduates and graduate students of literature, this volume constitutes a historical survey of the development of postmodern literary theory and criticism over the past twenty years in the United States and Europe. It deals with the theoretical movements of structuralism, hermeneutics, deconstruction, phenomenology, semiotics, social critique, and historicism.

FLETCHER, William H., Assistant Professor, "Didaktische richtlijnen voor het gebruik van de achter-

zetsels," in *Verslag van het Negende Colloquium van Docenten in de Neerlandistiek aan Buitenlandse Universiteiten*, Katholieke Universiteit Nijmegen, 26-31 augustus 1985, eds. Theo Hermans, Dick Boukema, and Andre van Seggelen. The Hague: Internationale Vereniging voor Neerlandistiek, 1986, pp. 59-73.

In Dutch, ten prepositions can follow their objects (i.e., are postpositioned) under conditions which have never been explained satisfactorily. This study examines all the postpositions in a seven hundred thousand-word corpus and additional examples to isolate the factors which condition the appearance of postpositions and to formulate pedagogically useful rules for teaching them to learners of Dutch. Usually postpositions occur in adverbials of direction. They generally appear instead of their proposed counterparts if confusion between direction and location is possible. In contrast to *naar* "to," they stress reaching a goal, not mere directionality. As past scholarship has shown, there exists a relation between postposition and aspect. This study systematically describes the aspectual interaction between postpositions and verbs. After a number of miscellaneous rules, it concludes with a look at idiomatic expressions with postpositions.

FLETCHER, William H., Assistant Professor, editor, *Papers from the Second Interdisciplinary Conference on Netherlandic Studies*. Lanham, New York, London: University Press of America, 1987.

This volume is a report on the Second Interdisciplinary Conference on Netherlandic Studies, held at Georgetown University from 7 June to 9 June 1984, which was organized by the editor. It chronicles the scholarly and social events of the conference and reproduces fourteen of the papers presented there. All of the papers deal with the Low Countries, i.e., the Netherlands and Belgium; the scholars who wrote them represent the fields of history, contemporary society, language teaching, linguistics, literature, and art history.

FLETCHER, William H., Assistant Professor, "Semantic Factors in Dutch Gender Choice," *Papers from the Second Interdisciplinary Conference on Netherlandic Studies*, ed. William H. Fletcher. Lanham, New York, London: University Press of America, 1987, pp. 51-63.

Like most European languages, Dutch distinguishes more than one gender of nouns. While grammarians prescribe that pronouns referring to inanimates must agree in gender with their antecedent, for most speakers in the western Netherlands this is often not the case. This paper demonstrates that such deviation from the norm is not random: it follows clear patterns which suggest the introduction of new semantic content ("relative degree of prominence as an individual") to what had become empty forms reflecting gender. Semantic features associated with greater prominence are human, animate, count, specific, and concrete, versus less prominent, non-human, inanimate, mass, general, and abstract. Some examples are adduced to show traces of this semantic principle in lexical gender assignment. Deviation from the prescriptive norm offers the clearest argument that traditional rules do not reflect the factors regulating actual usage; furthermore, the vast majority of cases which appear to conform to the rules also agree with the author's interpretation of the principles underlying Dutch pronoun reference.

HALBIG, Michael C., Professor, *The Jesuit Theater of Jacob Masen: Three Plays in Translation with an Introduction*. New York and Bern: Peter Lang, 1987.

Jacob Masen (1606-1681) was one of the pre-eminent German writers still using Latin as a literary language in the seventeenth century. Written in Latin

rather than the vernacular, his theater has not enjoyed wide exposure in this century because of the paucity of readers who can easily understand Latin. This edition includes a translation of Masen's three most notable plays: *Mauritius*, *Rusticus imperans*, and *Androphilus*. The introduction includes a brief biography of Masen and a discussion of Masen's theater in the setting of seventeenth-century dramatic theory and practice.

MARQUEZ, Enrique, Assistant Professor, *Lo esperado y lo vivido Borrowed Time*. Madrid: Playor, 1985.

This is a volume of poetry in Spanish with English translations by Kate Wheeler and the author, and a complete section in English only. The poems deal with perceptions of time, relationships, and the concept of renewal. The "world" and the "other" are scrutinized from two related points of view: the journey of survival of the nomad and the coming of a stranger, two form-generating conflicts that tend to bring about awakening to the real and the imaginary.

MARQUEZ, Enrique, Assistant Professor, "Visita-ción de la lluvia," "G.B.," "E.P. quiere morir," and "Fear of words," in *Poesía Cubana Contemporánea: Antología*. Madrid: Editorial Catoblepas, 1986, pp. 170-175.

Prepared by the Spanish publishing house Catoblepas (Madrid), this anthology includes three generations of well-known Cuban emigre poets (1930s through 1980s), who share both the experience of the Cuban revolution (1959) and exile in different parts of the world.

Presentations

CORREDOR, Eva L., Assistant Professor, "**La structure pre-romanesque d'une fiction tragique**," Meeting of SATOR (Societe d'Analyse de la Topique Romanesque), College de France, Paris, France, 10-11 October 1986.

CORREDOR, Eva L., Assistant Professor, "**Gyorgy Lukacs and the Problematic Form of Modern Drama**," Convention of Modern Language Association of America, New York, New York, 27-30 December 1986.

CORREDOR, Eva L., Assistant Professor, "**Is there a Postmodern Historicism?**," Conference of the International Association for Philosophy and Literature, University of Kansas, Lawrence, Kansas, 30 April-3 May 1987.

CORREDOR, Eva L., Assistant Professor, Respondent to Fredric Jameson, "**Critical Theory Postmodernism**," Conference of the International Association for Philosophy and Literature, University of Kansas, Lawrence, Kansas, 30 April-3 May 1987.

DAHLGREN, Sharon, Associate Professor, and Martin D. HERZOG, Commander, USNR, (Mathematics), "**Seminar on Interactive Video**," Five Colleges Faculty Seminar, Mount Holyoke College, South Hadley, Massachusetts, 19-20 September 1986.

DAHLGREN, Sharon, Associate Professor, "**Thomas Corneille, Pedro Calderon, and the Semiotics of Comedy**," Convention of Modern Language Association, New York, New York, 28 December 1986.

DAHLGREN, Sharon, Associate Professor, Chairman, Panel Discussion on "**Computers and Golden Age Spanish Drama: Data Bases, Data Banks, and Word Processing**," Golden Age Spanish Drama Symposium, University of Texas, El Paso, Texas, 13 March 1987.

DAHLGREN, Sharon, Associate Professor, "**Performance Codes in Calderon's *Gran Teatro del mundo***," Golden Age Spanish Drama Symposium, University of Texas, El Paso, Texas, 13 March 1987.

FLETCHER, William H., Assistant Professor, "**Zur Semantik und Pragmatik der Genusformen in Niederlandischen**," University of Cologne, Cologne, Germany, 16 June 1986.

FLETCHER, William H., Assistant Professor, "**Patterns of Dutch Pronouns**," Convention of Modern Language Association, New York, New York, 28 December 1986.

FLETCHER, William H., Assistant Professor, Chair, "**Three Dutch Revolutions: 1747, 1787, 1795**," at Folger Library Symposium "**Decline, Enlightenment and Revolutions: The Dutch Republic in the Eighteenth Century**," Washington, DC, 12-14 March 1987.

GILMORE, Elsa M., Assistant Professor, "**Aporte a la correspondencia de Cesar Vallejo**," Mountain Interstate Foreign Language Conference, Winston-Salem, North Carolina, 11 October 1986.

GILMORE, Elsa M., Assistant Professor, "**Antecedentes de la poesia epica de Cesar Vallejo en Los heraldos negros**," Kentucky Foreign Language Conference, Lexington, Kentucky, 24 April 1987.

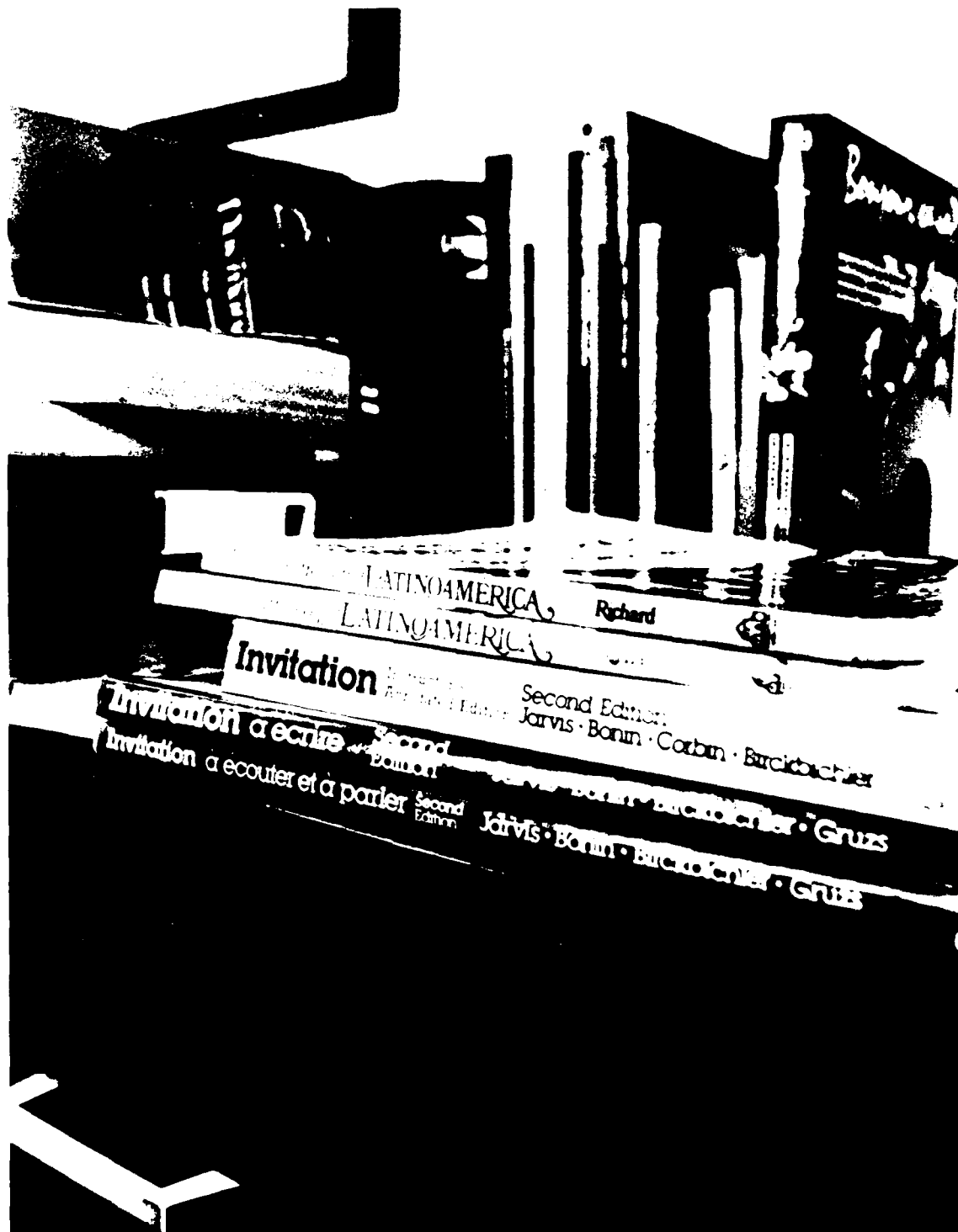
GILMORE, Elsa M., Assistant Professor, "**Audio-visual Materials in Foreign Language Instruction at the USNA**," Pennsylvania Modern Language Association, Allentown, Pennsylvania, 2 May 1987.

HALBIG, Michael C., Professor, "**Foreign Language Education and the New Information Environment**," Keynote Address, CALICO (Computer-Assisted Language Learning and Instructional Consortium) Symposium, Monterey, California, 8 April 1987.

MARQUEZ, Enrique, Assistant Professor, "**Inca Stones and Gianbattista Vico: the Concept of Historical Knowledge in Jose Lezama Lima**," Kentucky Foreign Language Conference, Lexington, Kentucky, 24 April 1987.

RIVERA-LA SCALA, Gladys, Associate Professor, "The Annapolis Interactive Video Project: Criteria Used for Selection of Software and Hardware," Inter-agency Language Roundtable, Washington, DC, 19 February 1987.

YARBRO, John D., Professor, "Interactive Computer-Videodisc Lessons for French Listening Comprehension," CALICO (Computer-Assisted Language Learning and Instruction Consortium) Symposium, Monterey, California, 8 April 1987.



Political Science

PROFESSOR ROBERT L. RAU
CHAIRMAN

In 1986-1987 the Political Science Department research and publication results demonstrated increased volume and high quality. The Department's faculty was recognized with a variety of research grants, travel grants, and publication of book-length manuscripts by the better publishers. Assistant Professor Gale Mattox edited *Evolving European Defense Policies*, and Associate Professor Stephen Frantzich published *Storming Washington: An Intern's Guide to National Government*. Professor Robert Rau was the recipient of a study grant to attend the International Summer Course on International Security, Institute of Political Science, Christian-Albrechts University, Kiel, Germany. It is of interest to note that most of the research undertaken in this department was unfunded. Also of some importance is the fact that most research is devoted to policy-oriented matters of functional problems and issues. In addition to the two books published by members of the Department, five chapters were contributed to books edited by others. Five articles were contributed to journals. Twenty-one professional papers were presented at conferences. Also, one report was written. Twenty-three presentations were given to professional or educational groups.

Faculty Midshipmen Research Project activity continued to improve, with a special interest in international relations and area-oriented topics. Twenty-five projects were completed by midshipmen. Fourteen midshipmen participated in five student conferences at Texas A. and M. University, the U.S. Air Force Academy, and the U.S. Military Academy, as well as the Student Conference on International Affairs at Mount Holyoke College, and the Columbia University Foreign Affairs Conference.



The establishment of the Honors Program for Political Science midshipmen has yielded research benefits for this department. Examples of independent studies written in honors courses are Midshipman 2 C Pamela L. Hilton's "The Islamic Fundamentalist Revival in Malaysia: Effects on Government and Public Policy" and Midshipman 2 C Travis D. Zach's "Recent Trends in Soviet Propaganda Efforts in Western Europe."

Sponsored Research

The Problem of Retention of Naval Pilots

RESEARCHER: PROFESSOR CHARLES L. COCHRAN

SPONSOR: COMMANDER, TRAINING COMMAND, U.S. ATLANTIC FLEET

There has been an improvement in military recruiting and retention rates since 1980. Problems remain in the retention of certain officer categories such as nuclear submarines and pilots. Problems persist because of inherent negative aspects of the quality

of life issues in these billets, as well as questions regarding the allocation of resources. Retention is found to be related to several variables including: age, marital status, source of commission, and others.

National and International Factors in State Repression

RESEARCHER: ASSISTANT PROFESSOR BARBARA HAREF

SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

This research project is a data collection effort which is part of a larger project that develops and tests a theory of the domestic and international causes of massive state repression. Information is being collected for all post-1945 cases of two types of mass repression—genocides and politicides. The initial global survey has identified about 45 definite and likely episodes. Detailed descriptions are being developed for each, including assessments of governmental tactics, identification of the target groups

and number of victims, and specification of the political circumstances of massive repression. The ultimate goal is to specify a general theory of state coercion and to demonstrate empirically that this theory has the capacity to explain the causes and processes of past episodes of massive state violence, and hence has the potential for forecasting them in the future. The results of the study will be incorporated in a book manuscript.

Evolving European Defense Policies

RESEARCHER: ASSISTANT PROFESSOR GALE A. MATTOX

SPONSOR: NATO FELLOW RESEARCH GRANT 1984-86

This is a study of the past policies, present trends, and future scenarios in the evolution of European defense from the 1970s into the 1990s. Its approach is two-pronged and addresses both national debates and overarching defense issues. The national defense agendas of the United Kingdom, France, West Germany, Holland, Italy, and Norway are examined across a range of issues. In each case, consideration is given to the political-economic context of defense policy, as well as the intradefense tradeoffs between men and material and between operations and capital investments.

A second section of issue studies includes poli-

cies and issues that cross boundaries, such as the balance between conventional and nuclear weaponry, burden-sharing, technical cooperation, arms control, out-of-area challenges, and the question of European defense cooperation. The editors conclude that change will occur through first, economic constraints; second, manpower constraints; and third, political pressure as a result of perceived economic advantage. The most dramatic change will be continuance of the trend begun in the early 1970s: the increasing role of the West Europeans in security and defense affairs in Europe, in NATO, and throughout the world.

The U.S.-Soviet Strategic Arms Limitation Talks

RESEARCHER: ASSISTANT PROFESSOR GALE A. MATTOX
SPONSOR: NAVAL ACADEMY RESEARCH COUNCIL (OMN)

The United States and Soviet Union have been engaged in nuclear arms negotiations since 1969. Those negotiations have been bilateral, focusing initially on strategic arms, but since 1982 including intermediate-range nuclear forces (INF) and since 1984 defense and space weapons. Particularly in the INF talks, but also the other sets of Geneva negotiations are increasingly important for the U.S. allies. This has been most convincingly demonstrated in the aftermath of the Iceland "summit" when a number of West European officials cautioned the United States against concluding an agreement with the Soviet Union that would in any way remove or undermine the U.S. nuclear guarantee.

The Federal Republic of Germany has been most vocal in expressing its concerns for the progress of the INF talks, as well as the strategic and space discussions. As a non-nuclear power bordering nine other countries and with the longest European border with the Soviet Union, it is perhaps not surprising that Germany voices concern over the potential for a conventional conflict in the absence of a firm U.S. nuclear commitment in Europe. The objective of the research is to define more precisely the Euro-

pean, especially German, concerns raised by the range of arms control negotiations now under bilateral discussion between the Soviet Union and the United States. There are a number of critical implications raised by the negotiations for the West Germans which deserve closer attention.

The method of this project will be to examine several central issues confronting the U.S. and its allies in the ongoing arms talks which can be expected to challenge existing alliance institutions or even fundamental assumptions with respect to NATO strategy. In the former case, will there be a need or is there a need now to alter the decision-making process within NATO? Will the Europeans begin to move more seriously in the direction of an independent security policy? In the latter case, if SDI portends the demise of nuclear weapons globally, what will be the implications for a NATO strategy based in the final analysis on the concept of nuclear deterrence? These issues are only beginning to be addressed in any detail in the public debate. Their resolution will be critically important to the United States and its allies.

Cognitive Processes and Political Decision Making: An Information Processing Perspective

RESEARCHER: ASSOCIATE PROFESSOR HELEN E. PURKITT
SPONSOR: NATIONAL SCIENCE FOUNDATION

This study focuses on how people process information to make a decision about a complex political question, to wit: what to do about very large and growing budget deficits, given the opportunity to increase taxes and/or decrease spending. Twenty-five small group sessions were videotaped in order to study the cognition, information processing, and choice heuristics of novices and experts. The type of information (qualitative) and subject characteristics (novice and expert) were the major treatment variables in this study. The results of the study demonstrated three main points: (1) experts (people with management analyst experience) and novices (college students) often attempt to solve a complex political problem in similar ways; (2) varying the type of problem relevant information presented

to experimental subjects does not influence the problem solving logic; and (3) problem responses are often preferentially based (e.g., partisanship and attitudes about defense, taxes, and social welfare spending trigger pronounced problem solutions). The most important result of this study is evidence that experts and novices use a low-level judgmental heuristic to understand a problem and to make decisions. The pervasiveness of this heuristic may explain why most political decisions approximate a satisficing incremental model. The results of this study suggest that it may be useful in future research to reconceptualize satisficing incrementalism as a pervasive type of judgmental heuristics used in political decision making.

Independent Research

Latin America in the International Political System

RESEARCHER: PROFESSOR G. POPE ATKINS

This book, to be published in 1988, is an updated, fully revised second edition of a work first published in 1977. It is an analytic treatment of Latin America's international relations, viewing the region as a subsystem within the global international system. Several levels of analysis are pursued: (1) the foreign policy interests, orientations, and processes of the relevant states, inside and outside the region; (2) characteristics and interests of the most important non-state actors; (3) structures and processes of the

numerous intergovernmental organizations in which Latin American states have participated; (4) the distribution of international power and influence involving the region and its subregions; (5) patterns of interaction in terms of diplomatic, cultural, economic, and military instrumentalities, both confidential and cooperative; and (6) the consequences of interaction in terms of several schools of international relations theory.

The United States as Regional Hegemon in the Caribbean Basin

RESEARCHER: PROFESSOR G. POPE ATKINS

This chapter has been completed and will appear in a book to be published in 1988. It analyzes U.S. threat perceptions in the Caribbean Basin and strategic responses to those threats as the United States has sought to play the role of regional hegemon. Analysis involves U.S. strategic concepts and how they are linked to ideological, economic, and other considerations. The first part is an exploration of the general and continuing bases for U.S. policy,

with particular attention to the Caribbean crises dating from the Nicaraguan revolution of 1979. The motivations of the various challengers, bargainers, and defendants are subsequently evaluated, including the degree to which they seem to conform or not to U.S. perceptions. A set of conclusions summarizes the theoretical and policy implications of the U.S. experience as hegemon in the Caribbean Basin.

The 1986 Elections in the Dominican Republic

RESEARCHER: PROFESSOR G. POPE ATKINS

This chapter has been completed and will be published in 1988. It is a detailed description and analysis of the 1986 national elections in the Dominican Republic, which were notable for a number of reasons. They were the sixth to be held in an unbroken quadrennial series that began in 1966 and served to reinforce the Dominican Republic's evolving democracy. While some violence occurred during the campaign and on election day, the general political atmosphere was peaceful, given the intense nature of the process. Despite serious national problems, the

campaign emphasized personalities rather than issues. A new "unitary ballot" discouraged voter fraud, encouraged party alliances, and de-emphasized the need for many candidates to campaign. Of particular importance, the appointment of a distinguished citizen's Advisory Commission to oversee the elections had the salutary consequence of ensuring an honest and peaceful outcome. In general terms, the elections signalled a political transition period as the parties and their leaders were open to realignment, possibly in fundamental ways.

C-SPAN in the Classroom, Providing a Window on the Legislative Process

RESEARCHER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The cable coverage of Congress (C-SPAN) offers a tremendous resource for teachers of political science. This essay discusses the use of C-SPAN in the classroom, and an annotated course syllabus outlines a

set of practical assignments by which C-SPAN can be integrated into a number of courses. The paper will serve as the basis for a summer seminar for college teachers.

Political Parties in the Age of Technology: The Legislative Process

RESEARCHER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

This project is a book-length manuscript (accepted for publication and in the final review process) which focuses on the role of information and communications technology in the future of American political parties. The thrust of the book is that the

future of the political parties lies in their ability to become indispensable to candidates in efficiently providing campaign services. The shift to service-vendor parties has significant implications for the future of democratic elections.

Public Access to Congressional Information: The Potential and Pitfalls of Technology-Enhanced Access

RESEARCHER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The demands of representative government require public access to information concerning the decisions of public officers. Modern information technology is a two-edged sword offering the potential of providing citizens with more information in a

more usable form, while threatening to increase the inequalities of information access. Congress needs to assess the role it will play in encouraging the provisions of its information to the public in the most technologically advantageous form.

European Problems of Security and Arms

RESEARCHER: ASSISTANT PROFESSOR GAIL A. MATIEX

There is currently a wide-ranging debate within the Atlantic Alliance over the requisite balance of conventional and nuclear forces and the pressing necessity to control arms. The traditional arguments in favor of extended nuclear deterrence through a strategy of flexible response are under challenge by some publics and even selected officials. While the dilemmas of deterrence are not new to the United States and its allies, the current superpower arms control discussions make clear decisions of force requirements for the near and long-term future imper-

ative. In this chapter the attempt will be to review the challenges posed by the arms control negotiations to European security and to present the major issues of the present public debate.

The chapter will be a general introduction to a number of separate chapters addressing specific issues of European security. The book is designed to serve as a basis of discussion for the annual national conference of the American Academy for the Advancement of Science in October 1987.

The Effect of Arms Control on Nuclear Conventional Forces in the Federal Republic of Germany

RESEARCHER: ASSISTANT PROFESSOR GALE A. MATTOX

This research began this spring and will be pursued over the next six months. The resulting chapter will be a contribution to a planned book on the West German Bundeswehr. In manuscript form, the chapter will be critiqued by Dr. Christopher Bertram, a former Director of the International Institute for Strategic Studies and current editor of *Die Zeit* and,

in the late fall, submitted for discussion to a conference on the Bundeswehr sponsored by the American Institute for Contemporary German Studies. The objective of the conference is to encourage and bring together U.S. scholars in the area of German defense policy.

Polish-American Relations Since the Imposition of Martial Law

RESEARCHER: ASSOCIATE PROFESSOR ARTHUR R. RACHWALD

The purpose of this study is to analyze Polish-U.S. relations and their impact on Polish domestic and foreign policies since the imposition of martial law on 13 December 1981. This military takeover, designed to preserve the dominant role of the Communist party in Poland, frustrated the considerable progress in mutual relations recorded in Polish-U.S. ties that had been made in the previous decade.

The reaction of the U.S. government to the military takeover in Poland was a result of American rejection of General Jaruzelski's assertion that martial law was a "lesser evil" in that it preempted direct military intervention by the Soviet Union. According to President Reagan, the military in Poland acted in the interest of the ruling elite who were posturing as patriots concerned with the well-being of the nation. The United States also rejected the Polish government's opinion that the excessive political and economic demands of Solidarity fully justified General Jaruzelski's actions.

Consequently, the United States, refusing to endorse General Jaruzelski's self-image as a Polish nationalist who was forced to take unpopular measures to prevent his nation from being overcome by external force, rejected Warsaw's appeal for "business as usual" between the United States and Poland.

Among the economic sanctions imposed on Poland by the Reagan Administration were a moratorium on new credits; termination of Polish fishing rights in U.S. waters; an end to agricultural aid; suspension of all LOT (Polish Airlines) services to the United States; and refusal to negotiate the rescheduling of Poland's debt. Eventually, in response to the delegitimation of Solidarity, the United States withdrew from Poland its most-favored-nation status. It was made clear that all these sanctions against Poland were reversible if and when substantial progress in human rights were made. In the meantime, the United States continued to send humanitarian aid to the Polish people via private organizations in Poland, such as the Roman Catholic Church. This state of affairs created a very complex situation between the United States and the second most important member of the Soviet block.

This study will examine the course of Polish-American relations during the first half of this decade, particular attention being focused on internal political and economic development in Poland and the impact of both on Polish relations with the United States. It will also assess the general framework of current American policy toward Poland and, perhaps, toward Eastern Europe in general.

Human Rights and the American National Myth

RESEARCHER: INSTRUCTOR STEPHEN D. WRAGE

The dissertation examines the issues of human rights in American foreign policy from a historical perspective. It asks why human rights, which are generally taken to be at the core of the American system of values, were not featured on America's foreign policy agenda before 1976, and why they figured so prominently at that time.

The researcher looks for answers in the workings of the American national myth (i.e., the set of propositions through which Americans describe to themselves their shared sense of the nation's purpose and destiny). The dissertation records the propositions that make up the national myth as they are found in sermons, speeches, editorials, art, and literature of all kinds. It examines the way human rights function in those propositions, and finds that for two hundred years after the founding of the

republic, the national myth provided a rationale for passivity with regard to the promotion of human rights throughout the world. Confidence that it was America's destiny to serve as a model for all mankind rationalized inaction in the cause of propagating the nation's values, at least on the national policy level. By 1976, however, an array of disillusionments had undermined that confidence and undercut that rationale. Consequently, Americans at last committed themselves to an aggressive human rights policy, to recapture a vanishing belief in their national destiny, and to restore a shaken national myth.

The dissertation concludes that as an issue in American foreign policy, human rights matter primarily as a means to affirm and sustain the national myth, and not as an end in themselves.



Research Course Projects

Future Directions in National Space Policy

RESEARCHER: MIDSHIPMAN 1 C DANIEL J. ALDRIDGE
ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRATZICH

The Challenger disaster offers an important opportunity to reflect on the development of national space policy and to provide some guidance for its future development. This paper analyzes these two

goals and tests the hypothesis that military and national security interests have been the primary force behind the civilian space program and may well be even more important in the future.

A Rangoon Legacy: The Terrorist Attack on the 1988 Olympic Games

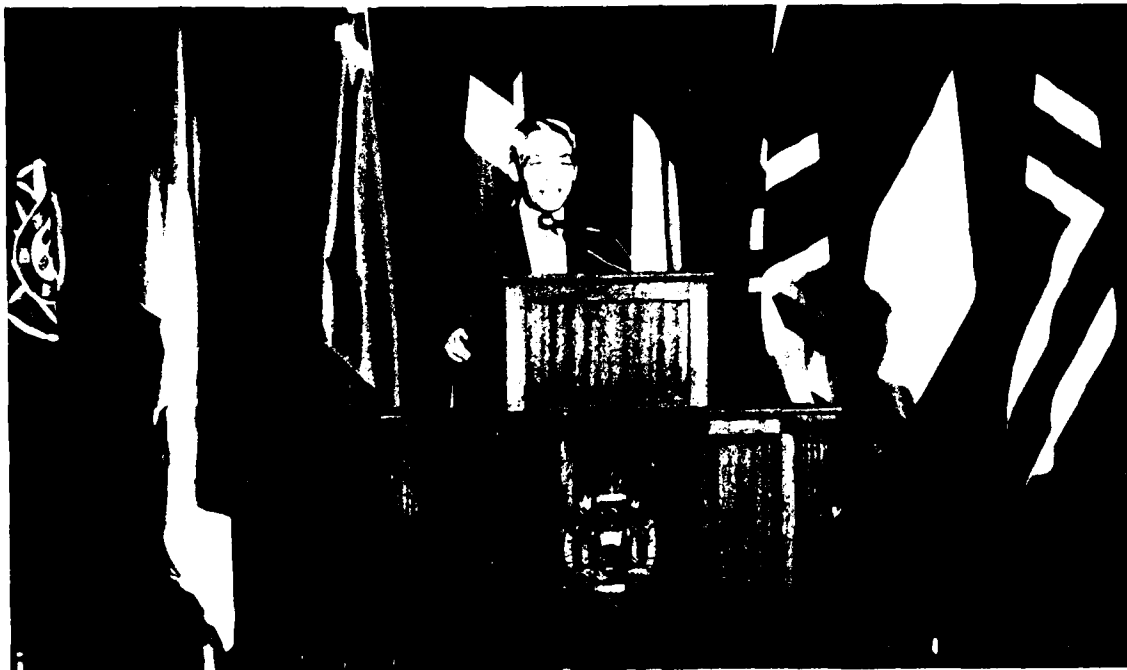
RESEARCHER: MIDSHIPMAN 2 C WILLIAM W. BURKHART
ADVISER: FOREIGN SERVICE OFFICER JOHN D. COFFMAN

The North Korean-sponsored terrorist attack in Rangoon almost succeeded in changing the government of South Korea by eliminating the President and many of his senior advisors. It was human error, not security measures, that saved the president and, of course, a number of senior South Korean officials were killed.

Using that incident as a base, this paper describes the planning and execution of a three-pronged terrorist attack against the 1988 Olympic Games to be held in Seoul. Perspective is through

the eyes of the North Korean official in charge of the action. The commander must deal with stringent South Korean technical and human security in such a way that effect is maximized and North Korean involvement is hidden. The plan is to defeat the security measures by forcing human error.

A number of technical security elements are evaluated and supported by descriptive data sheets. The inherent limitation of depending upon technical defensive devices is made quite clear and two of the three attack goals are achieved.



Mao Zedong: The Primary Architect of the Chinese Communist Revolution

RESEARCHER: MIDSHIPMAN 1/C RICHARD J. CHAO

ADVISER: PROFESSOR ROBERT L. RAU

Dynasties had come and gone in the cycle of Chinese history for more than three thousand years until the Nationalist Revolution of 1911. Then in just twenty-eight years since the founding of the Chinese Communist Party in 1921, the communists emerged as the rulers of Mainland China. How did Mao and his followers achieve power? What kind of political philosophy or ideology motivated the Chinese Communist Revolution?

The first part of this project investigated briefly the political history of China prior to the revolution and the character of Mao to see what kind of revolutionary figure was produced under extreme political chaos in China.

The second part of the project explained in detail the foundation of Mao's political thought—the *theory of contradiction*. This theory of contradiction was applied to every aspect of the Chinese revolution process, not just before 1949, but including the Cultural Revolution of 1966. This dis-

tinctive variation of the Marxist-Leninist ideology, better known as Maoism, was built on this theory.

The third part of the project analyzed the applications of Maoist revolutionary theory throughout the various stages of the Chinese Communist Revolution. The analysis included political, psychological, diplomatic, and military techniques used to further the cause of the Communist Party.

As part of the conclusion, this research report indicated that Mao was the most important contributor to the revolution. But towards the end of his reign, Mao Zedong became the people's emperor, and the Chinese Communist Party became a feudalistic bureaucratic machine just like the old emperors and the archaic Mandarin system the communists had fought to destroy. This phenomenon led the researcher to wonder how long the Communists will retain their position of power until they, like their predecessors, become only a chapter of Chinese political history.

International Conflict and the Antarctic Treaty

RESEARCHER: MIDSHIPMAN 1/C TIMOTHY J. CORKERY

ADVISER: PROFESSOR G. POPE ATKINS

Territorial claims have complicated international relations in the Antarctic throughout the twentieth century. This research project focuses on the problems and prospects for conflict in the region, with reference to the overlapping territorial claims by Argentina, Chile, and the United Kingdom. The researcher first examines doctrines that these countries have variously asserted to support sovereign claims: historic right, geologic affinity, proximity,

and contiguity, the sector principle discovery, and occupation. He then analyzes the role of the Antarctic Treaty of 1959 in temporarily setting aside conflict, as well as the maneuverings by the three claimants as they approach a probable treaty-review process in 1991. Conclusions are drawn about possible future conflict scenarios, depending on decisions made about the fate of the Antarctic regime.

SDI—The Soviet Perspective

RESEARCHER: MIDSHIPMAN 1 C ALEXANDER EDWARDS
ADVISER: ASSOCIATE PROFESSOR ARTHUR R. RACHWALD

This research project was limited exclusively to the Soviet sources dealing with the issue of SDI. Examination of the Soviet literature of this subject indicated that the Soviet authorities are deeply apprehensive about the SDI because of three reasons: (1) Moscow is afraid that the thwarted United States may require the first strike capability; (2) the Soviets do not like high-tech competition; and (3) Soviet

economy may no longer be able to sustain another round of the strategic arms race.

On the other hand, the Soviet leaders perceive SDI as an expression of the traditional American isolationism, and politically use the SDI controversy to de-couple U.S. and West European security interests.

Ingredients for Successful Superpower Relations: A Case Study of Detente and the Incidents at Sea Agreement

RESEARCHER: MIDSHIPMAN 1 C KEITH E. FOLKERTS
ADVISER: ASSISTANT PROFESSOR GALE A. MATTOX

This project was an independent honors project. It included an indepth review of the literature on detente. Faced with the lack of any significant material dealing with the case study on the Incidents at Sea Agreement, the investigator supplemented the research with personal interviews of selected participants in the Incidents at Sea negotiation process. The project combines a broad review of detente policy and more specific details of the case study. The following conclusions were drawn from the research:

This study has attempted to examine the pitfalls and successes of the detente era in a search for a viable state of United States-Soviet relations. Historically, three approaches have been seen to work with differing degrees of success. First is the course

of making known the American viewpoint and doing nothing more. Second, one can make known American wishes and persuade the Soviets to help alleviate the problem. Third, one can compel changes from the other side by using threats and linking outside factors to the problem. These policies have produced some success, but there is much room for improvement.

Future relations should be based on understanding and reciprocity, an example of which can be seen in the Incidents at Sea Agreement. This Agreement has been a successful part of United States-Soviet relations, despite other problems and setbacks. By using it as an example, its success could be the norm for United States-Soviet relations, not the exception.

The Effect of the Media on Coercive International Relations

RESEARCHER: MIDSHIPMAN 2 C MAXIMILIAN A. GRANT
ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The media do more than record international conflicts and controversies by becoming part of the controversies themselves. There is a critical balance between the public's "right-to-know" and the needs of the military for secretive action. This paper ad-

dresses the general issue of the role of the media in international relations, and uses the Grenada invasion as a case study of attempts to control the media and the necessity of proper policies concerning press access.

The Struggle for Sovereignty in Politico-Military Affairs

RESEARCHER: MIDSHIPMAN 2 C MAXIMILIAN A. GRANT

ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The overlapping of jurisdiction between the State Department and the Department of Defense in the area of politico-military affairs is now well institutionalized and established. This overlapping is not only against pertaining separation of agency theory,

but also detrimental to the establishment and execution of a comprehensive and cohesive American foreign policy and strategic-military-type affairs. This can be found both historically and in practice today.

Appropriate U.S. Policy Toward Arms Control

RESEARCHER: MIDSHIPMAN 3 C MICHAEL K. HARNETT

ADVISER: ASSISTANT PROFESSOR GALE A. MATTOX

This project was both an independent honors research paper and a roundtable paper for the Naval Academy Foreign Affairs Conference (NAFAC). The subtopic was defined by NAFAC and required consideration of three possible arms control options for the United States—a test ban treaty, a non-proliferation treaty, and multilateral negotiations and agreement. After an indepth review and consideration of the secondary and primary literature, the following conclusions were reached:

The United States must determine which type of arms control agreement will promote international security and support U.S. national security objectives. While deciding among test ban treaties, non-proliferation treaties, or bilateral reductions, the United States should take into account the technological advances that have influenced the arms race since 1949.

The test ban treaty has been a very controversial type of agreement in Washington over the last few years. The Reagan Administration argues that the U.S. needs to test its nuclear explosives in order to maintain NATO's state of readiness, as well as the Triad's deterrent function. Proponents of

the treaty argue that such testing is unnecessary and allows for advances in nuclear destructive capabilities.

The non-proliferation treaty is an excellent means of retarding the spread of nuclear arms and promoting world stability. Although the non-proliferation treaty of 1970 was an important step in this direction, no matter how strongly supported by the world community, the treaty cannot reduce the nuclear arsenals that exist today. Bilateral and eventually multi-lateral reductions, however, have the potential to end the threat of nuclear war, and they certainly support U.S. national security objectives. The arms reduction proposals of both superpowers and the present talks in Geneva show promise of such an agreement by the end of the century.

The United States should pursue bilateral nuclear arms reductions, taking into account that technological improvements in verification methods may help bring about a treaty. Technology has also made the arms race more threatening, by adding to the destructive capabilities of both superpowers. In short, the time for an agreement is now.

The Islamic Fundamentalist Revival in Malaysia: Effects on Government and Public Policy

RESEARCHER: MIDSHIPMAN 2 C PAMELA L. HILTON

ADVISER: PROFESSOR ROBERT L. RAU

This paper concerns itself with the Islamic fundamentalist (*dakwah*) movement that is presently sweeping through the ranks of young and middle-aged Malaysians. This movement is potentially dangerous, as Malaysia is a multi-racial country, composed primarily of Malays, Chinese, and Indian groups. The *dakwah* movement tends to polarize further an already disparate society by encouraging distinctive clothing and allowing only Malays truly to join the movement, although some Chinese are allowed in fringe groups. These actions have provoked similar groups in the other two races. Some inter-racial, or inter-faith incidents have occurred, but the Malay police force, well educated by the rioting of 13 May 1969, has held disturbances to a minimum.

The three major *dakwah* organizations are discussed: they are *Jema'at Tabligh*, an Indian inspired movement, *Darul Arqam* (the house of Arqam), and *Angkatan Belia Islam* (ABIM), an influential youth movement. Each has its strengths and weak-

nesses, but the same basic purpose: to initiate a return to strict, canonical Islam while remaining in touch with the modern world. All fulfill a basic need in many Malays, in providing a sense of security and belonging to a race cut loose in a modern world that few understand. *Tabligh* does this through *jema'ah* (lectures); *Darul Arqam* through self-sufficient (*Bendi Kari*) communities; and ABIM through youth groups, schools, and some unofficial political ties to a major Islamic party, PAS.

How, then, does this affect the political processes on the national level? Under Mahathir Bin Mohamad, Prime Minister of the present government, Islamization has been rather rapid. New laws following Koranic tradition, like the banning of rock concerts and the establishment of National *Dakwah* Month, have been instated. However, protests are beginning to rise from the Chinese and Indian communities, as well as from their elected representatives. Each faction knows that the *dakwah* movement has grown too great simply to suppress.

Balancing Technology Transfer to the East vs. Increasing Demands From the U.S. Private Sector to Increase Exports

RESEARCHER: MIDSHIPMAN 1 C GREGORY D. HITCHAN

ADVISER: ASSOCIATE PROFESSOR ARTHUR R. RACHWALD

In today's economic environment, imposing controls is a difficult task, because they disrupt commercial trade. However, these losses in export must be balanced with the less extensive gains in our national security.

Effective and consistent controls require a strong consensus for maintaining security among the Western nations. While progress has been made among NATO allies, much more needs to be done.

Western governments must improve their control over the transfer of critical technologies. This requires greater cooperation among the government agencies in their licensing review and approval process. These governments should also consider the feasibility of their controls, and limit them to truly

critical technology. This would enable their business communities to remain competitive in the world market.

The transfer of technology to the Soviet Union and its Eastern European allies slowly saps the West's military and economic strength. The challenge exists for the West to assess properly and balance the economic benefits with the security risks in trading with the Soviet Bloc countries. In these politically unstable times, the world's largest military and industrial power must assume the lead in the establishment of a comprehensive export control policy for Western Nations. In order for the U.S. to answer this challenge, it will require the support of industry and the cooperation of its allies.

Prospects for the Unification of the Republic of China and The People's Republic of China

RESEARCHER: MIDSHIPMAN 1 C PETER M. HUTSON

ADVISER: PROFESSOR ROBERT L. RAU

The researcher studied the Republic of China (ROC) and the People's Republic of China (PRC) and the prospects of unification. He analyzed the possibility of there ever really being "one China" - a goal that both governments currently claim to pursue.

The report on the unification analysis of the PRC and the ROC included major subsections such

as the introduction of the issue, a historical background, a description of the nations today, U.S. involvement, perceptions of each party, means of reunification, the prospects of reunification, and a conclusion. Maps, charts, bibliography, and footnotes were also included.

An Analysis of the Use of Military Force in Response to Terrorist Incidents

RESEARCHER: MIDSHIPMAN 1 C JEFFREY P. KANE

ADVISER: FOREIGN SERVICE OFFICER JOHN D. COFFMAN

Terrorism is a threat to the safety of many people in the world today. Even the largest nations are not immune from its sting, thus precautions must be taken. The methods of combatting terrorists have been evaluated and some important conclusions reached. Military force has, time and time again, been proven to be an effective counter to terrorist activities. An essential caveat is that the use of such tactics is situation-dependent.

In this paper an attempt was made to evaluate those factors which could reasonably lead decision makers to utilize the force option in response to a terrorist act; also considered were factors which preclude the use of military force. The case-study

approach was used to study Israeli, Egyptian, West German, and American military responses. By examining selected incidents, certain conclusions were reached, and applied to other incidents.

Terrorism is a threat which will not go away; it confronts everyone, especially those in positions of power within the world's governments. Because terrorism is a threat that will not go away, reactions to terrorist activity must be planned, and implemented if necessary. Although many would consider the use of force against terrorists to be a last resort, it remains a viable and effective method of dealing with the problems associated with terrorism.

Nikita Khrushchev and the Soviet Union

RESEARCHER: MIDSHIPMAN 1 C DAVID R. KLESS
ADVISER: ASSOCIATE PROFESSOR ARTHUR R. RACHWALD

This research project examined political and economic reforms in the Soviet Union under Nikita Khrushchev (1953-1964).

Although Nikita Khrushchev was the only premier to be ousted from office, he did some good for the country. He initiated the idea of mutual cooperation among the Soviet Union, the United States, and Europe. He began forming the base for what today is referred to as detente. Although tensions are high and views are different between the two countries, both have been able to co-exist peacefully so far. Khrushchev presented the idea that the superiority of one country should be displayed through peaceful means instead of military force.

He made it clear that it is impossible for one man to solve all the problems by himself. It is not in the best interest of the country to let one person make

all the decisions on his own. Khrushchev failed because he tried to make decisions based on ideological theories instead of reality. All future decisions must be made by a group of open-minded individuals who understand what is happening around them. Khrushchev had a lot of good ideas, but he was unable to accomplish his goals, because he did not attack them with the correct methods. Many others have used his ideas but learned from his mistakes and sought the solution differently. An effective leader is one who defines a problem and then finds a solution to it. So, although Khrushchev is not considered one of the better leaders of the Soviet Union, he did provide the country with a lot of good ideas that have since helped the Soviet Union become a modern society.

Should the United States Adopt a Nuclear Test Ban As an Approach to Arms Control?

RESEARCHER: MIDSHIPMAN 2 C DAVID C. LYLE
ADVISER: ASSISTANT PROFESSOR GALE A. MATTOX

The research project was both an independent honors project and a roundtable paper for the Naval Academy Foreign Affairs Conference. The project included a very thorough review of the historical record of negotiating efforts for a nuclear test ban. Having established the historical background, the researcher undertook an indepth review of the current debate over the issue of a nuclear test ban. On the basis of the available literature and analysis, the following conclusions were drawn:

In a world where the superpowers have acquired a redundant capability to destroy each other, arms control has risen to the fore of the world agenda.

The conflicting ideologies of the United States and the USSR have led to mutual suspicion and mistrust, but surely the common interest of avoiding mutual destruction dictates that both must work together in the search for an arms control solution. To this end, the United States and the Soviet Union have both investigated the adoption of a comprehensive nuclear test ban (CTB) as a possible hedge against the escalation of the arms race. However, since the Eisenhower administration began CTB negotiations in 1958, the two parties have been unable to reach an agreement that is compatible with their individual national securities.

Bureaucracy and the Bureaucrat: The Development of a Theory of Change

RESEARCHER: MIDSHIPMAN 2 C MICHAEL J. MA

ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

In many ways, the individual can be seen as the root of all bureaucratic actions. The goal of this study is to see how an individual's view of his role in the bureaucracy changes over time. The motivations of a bureaucrat are shown as he assumes different roles based on self-interest. These roles are hypothesized to change as the individual goes through stages of development both in goals sought through the bureaucracy and in the approach taken to reach these goals. Certain identifying characteristics and motivations are associated with each of five stages. These stages are placed on a continuum of change from a "Novice" to an "Achiever" to a "Maintainer" to a "Contributor." The development between these

stages is posulated to occur as action as either a "Zealot" or an "Advocate."

In the application of this model, a total of sixteen interviews were conducted. The basis for selection of interviewees was to assure input from a wide variety of individuals from different bureaucratic systems, experience in bureaucracy, and perspectives in decision making. The responses to the questions were empirically coded and compared with the predicted responses of the archetypical representative of a given stage of bureaucratic development. The theory attempts to predict how an individual will act, based upon knowledge of the actor's position in the bureaucracy.

Washington's Nightmare: The Possibility for Burden Sharing in Alliances

RESEARCHER: MIDSHIPMAN 2 C MICHAEL J. MA

ADVISER: ASSISTANT PROFESSOR GALE A. MATTOX

This research project was both an independent honors paper and a contribution to the Naval Academy Foreign Affairs Conference. Its thesis was that the United States must be willing to take as well as give in areas of both materials and leadership in its alliances. After reviewing the issue of technological burden sharing in terms of NATO and ANZUS, the following conclusions were drawn:

The basic question of the equitable division of labor within NATO is summarized by the competition between nationalistic isolation and international reliance. The structure of NATO requires a certain abdication of protectionism to promote the common good and security of the alliance as a whole. Opposed to this sacrifice, however, is the nationalistic necessity to promote individual success at the expense of others. In a capitalist's world, competition is often seen to lead to increased efficiency and efforts at success. In the terms of alliance, however, extreme levels of competition between mem-

ber nations appear to lead only to divisiveness and the unneeded duplication of effort. This overall trend is particularly evident in a time when the interests of Europe and the United States appear to be increasingly divergent.

It would seem that the open-ended structure of the United States' alliance commitments lends itself well to reexamination of established precedent. The possibilities for further division of labor exist, but not without further definition of the roles of the member nations. This redefinition must include renewed commitment to a spirit of cooperation and the ability to sacrifice apparently nationalistic goals for the greater goals of security and overall prosperity. In the end, it will undoubtedly be seen that consensus is never easy. The most important change that can result is a willingness to question a system when it no longer works for a given political system or state of world affairs.

Factor Analysis of U.N. Voting, 1976-1986 Explaining Patterns on Issues and Alignments

RESEARCHER: MIDSHIPMAN 1 C SCOT W. MALLOY

ADVISER: CAPTAIN JOHN E. KRUSE, USMC

The General Assembly of the United Nations has served as a forum to the countries of this earth since its beginning in the late 1940s. Every nation represented in that body has its own predispositions and perspective, which allows them to organize and draw different conclusions from various sources of information. Having made individual interpretations of the situation, each country may then vote accordingly on the resolution placed before it. Unfortunately, because of the size of the assembly and the varying outlooks of each member, critical analysis of voting behavior has often been difficult. A method developed several years ago at the Massachusetts Institute of Technology by Hayward R. Alker, Jr. and Bruce M. Russett, utilizing factor analysis, has made this sort of research more feasible.

In the words of Alker and Russett, "The goal of factor analysis is to get at the basic issues and alignments underlying a wide variety of roll-call votes."

Factor analysis was used to construct from a larger group of characteristics a smaller set of general underlying causes or factors. The way a nation votes can be partially attributed to these various factors. Analysis of the factors allowed the researcher to draw conclusions about the trends in world politics.

The analysis of plenary role call votes in the years 1976 and 1986 showed dramatic changes in the world political order. Global issues have increased in importance, although regional groups have become more cohesive in the Third World. This has been especially true of the Islamic states. The cohesiveness of the West has been loosening on East-West issues, but the Eastern Bloc has held together. Correlation was not strong enough to draw conclusions in many other areas examined. The Alker-Russett model, however, provided useful methodological tools for validating international trends and alignments.

Venezuela's Foreign Policies

RESEARCHER: MIDSHIPMAN 1 C ANTONIO R. MARTINEZ

ADVISER: PROFESSOR G. POPE ATKINS

Domestic politics and foreign policies are directly linked in the case of Venezuela. Internal concerns often take precedence over, and always at least strongly influence, international objectives. Social issues are linked to domestic politics, domestic politics is linked to petroleum revenues, those earnings are linked to industrial and social development,

development is linked to Caribbean Basin regional stability, and support for stability is linked to foreign involvement. The present research analyzes the evolution of Venezuela's foreign policies over the past three decades, focusing on the domestic factors that have shaped them.

Human Rights and the Organization of American States

RESEARCHER: MIDSHIPMAN 2 C CRAIG M. MILLER

ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The first part of this three-part paper attempted to define the meaning of the term "human right" and the theory behind international attempts to regulate human rights at both the universal and regional levels. A brief summary of various attempts at such regulation followed, including organizations such as the United Nations, the Organization of American States (OAS), and the Organization of African Unity. Also outlined were some of the charters of these organizations as well as special commissions established.

The second part begins to focus on the Organization of American States. A description of its history from conception to its latest reorganization in 1967 follows, along with more particular descriptions of the offices and departments within the O.A.S. A special focus was made on the documents forming the foundation of the O.A.S.

The third and final part dealt with the two ma-

jor human rights documents produced by the O.A.S., and the special commission and court established as a result. The two documents discussed were The American Declaration of the Rights and Duties of Man and the American Convention on Human Rights. Outlined are the tenets of each document, signatory states, and actions taken as a result. Two of the more exciting bodies dealing with human rights were established by the American Convention, these being the Commission on Human Rights and the Inter-American Human Rights court. A history of each is provided, as well as analysis of their past and possible future opportunities to affect and improve the human rights situation in the Americas.

Concluding remarks reflect upon possible broadening of international human rights legislation with the emphasis on the establishment of substantial enforcement bodies.

Kampuchea: Inherent Disturbances

RESEARCHER: MIDSHIPMAN 1 C HEIDI J. MOSER

ADVISER: PROFESSOR ROBERT L. RAU

The purpose of this paper was to examine the current political state of Kampuchea and the factors, both past and present, that cause Kampuchea to be the nation of chronic problems that it is. The researcher looked into the historical, geographic, economic, societal, cultural, and political factors that affect the people and the land of Southeast Asia.

The first portion of the paper covers the history of Cambodia. It includes the geographical position of the state between Thailand and Vietnam and its location south of China. The development of the culture as it affects the Cambodian frame of reference was also traced. The structure of society and governmental systems was approached next. Specifically, the leaders as an influence on the people as a whole were looked at. The economic status of the people to maintain autonomy was included. Throughout the historical scrutinization, the researcher looked for trends in the factors mentioned that would affect the actions of the people and government today.

The second portion of this paper altered its perspective to examine the status of Kampuchea today, keeping the past in mind. A key focus was the Vietnamese occupation of the Kampuchean country. The involvement with the Association of South East Asian Nations (ASEAN) was also discussed. The influence of the USSR through covert channels and the diverse factions in Kampuchea also played a major role in the current situation. China also has interests in the Southeast Asian region. The research cited some of the alternatives offered by other writers on the subject, and added some of her own.

Finally, the researcher reached the conclusion that Kampuchea is a country ruled by circumstance. The problems are spurred by inherent conflicts, internally and externally, and conflicts that have developed with the growth of an ambitious nation. The researcher does not envision a satisfactory resolution for Kampuchea in the future.

The Warsaw Pact: Its Origin, Political Military History, and Its Future

RESEARCHER: MIDSHIPMAN 1 C CHRISTOPHER G. RAPP

ADVISER: ASSOCIATE PROFESSOR ARTHUR R. RACHWALD

Following a brief history of the Warsaw Pact since its establishment in 1955, this researcher concluded that politically the Soviet Union faces a major problem in that there will be many leadership changes within the Pact in the next decade. Almost all of the Pact's conservative, orthodox Communist lead-

ers are in their 70s. It will be a true test of the Soviet's political savvy to find new, strong leaders to replace the old leaders. The Soviets may find new leaders who are willing to follow the Soviet model, or the Soviets could lose control of the Pact's direction.

Technology and Terrorism: How to Win

RESEARCHER: MIDSHIPMAN 2 C TIMOTHY M. SALMON

ADVISER: FOREIGN SERVICE OFFICER JOHN D. COFFMAN

Terrorism is premeditated, politically motivated, indiscriminate violence perpetuated by those desiring to influence government policy. The most powerful nations have been confounded by terrorists who, while not able to gain power, have been able to extort responses favorable to their position. Hence, the researcher's purpose is to gain an indepth understanding of the problem in order to develop a policy which would best combat the threat. If governments are to carry out normal diplomatic functions, then such research could not be more timely.

In order to counter both indigenous and international terrorism, it seems most evident that extensive intelligence operations must continue to be supported by the free world governments in a cooperative effort to lessen the effects of bombings, kidnappings, hostage takings, and armed assaults.

Advanced technology in the form of satellite communication, as well as miniaturized gadgetry, such as listening bugs and telephoto lenses, has helped support human intelligence-gathering operations.

Technology can be applied to counter-terrorist operations. Elite security units, such as the United States Delta Force, use various devices to gain advantage. On a large scale, high performance aircraft and missile systems allowed the United States to carry out precision bombing against Libya in retaliation for terrorist activity backed by the government.

Yet, all the technology available is useless unless governments have the will to use it. It is the theme of this researcher's paper that those who illicitly wage war should be met with equally harsh retribution.

Race, Juvenile Delinquency, and School Suspension

RESEARCHER: MIDSHIPMAN 1 C JOHN B. SLAUGHTER

ADVISER: PROFESSOR JOHN A. FITZGERALD

Blacks are suspended from school at a rate four times that of whites. It was initially hypothesized that this reflects a higher delinquency rate among black students (the comparable phenomenon being a black prison population four times greater than the general black population). It was found, however, that delinquency did not correlate with increased suspensions. In fact, blacks were no more

delinquent than their white peers. Black students were four times more likely to fall into the lower SES categories. The research concluded that the causes for disproportionate suspensions are more class related than delinquency prominence related and that further analysis is needed to explain those behavioral characteristics associated with low SES that might logically contribute to school suspensions.

The Making of the 1988 Presidential Elections

RESEARCHER: MIDSHIPMAN 1 C RICHARD P. VITARO
ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

The purpose of this paper was to examine the early factors of the 1988 Presidential election. The paper used information from previous elections, along with articles speculating on the upcoming election.

The main thrust of the research was the relation-

ship of the media to the election. The researcher concluded that the media, as main sources of public information, fail to cover issues in depth. Instead, the media concentrate on the horse race aspect of the election.

Factors Influencing the East-West German Relationship: A Comparative Study of the Internal and External Factors That Affect the Inter-German Relationship

RESEARCHER: MIDSHIPMAN 1 C PAUL A. WALKER
ADVISER: LIEUTENANT COMMANDER LUANNE A. TURRENTINE, USN

The purpose of this study was to examine the factors that influence the inter-German relationship and attempt to determine which factors has had the most influence over that crucial tie. The factors were broken down into two parts, internal and external, with the main internal factor being the desires of the German people, both East and West. The main external factors were the attempts to gain influence over the inter-German relationship by the world superpowers, namely the United States and the Soviet Union. The study attempted to prove that despite internal desires concerning the relationship, it is often dependent upon external factors, such as the United States and the Soviet Union.

In conducting this study, an extensive amount of scholarly literature was reviewed, and the researcher conducted several interviews with the ex-

perts from the Department of State, the United States Information Agency, and the Georgetown University Center for Strategic and International Studies. The conclusion determined that the Soviet Union exercises the most influence in inter-German relations and plays a very important role in the foreign policy of West Germany. However, the Soviet Union does not have as much influence on the inter-German relationship as do the internal desires of the two populations of East and West Germany. The inter-German relationship will continue to be close because of the internal desires of both the population and the ruling leadership for the closest relationship possible. A close relationship within the context of their respective alliances is the working solution to the German Question.

Regional Interdependencies in Southern Africa

RESEARCHER: MIDSHIPMAN 1 C JOHN D. WILKINS
ADVISER: ASSOCIATE PROFESSOR HELEN PURKITT

Southern Africa is a complex region involving mutual interdependencies and conflicts among countries in this area. This project was designed to study regional linkages beyond the highly publicized political conflicts in an effort to understand the local dynamics of regional conflicts. The research centered on South Africa, which is the most powerful force in the region in terms of economic, political, and military power. Efforts were also made to identify changes in the relationships between South Africa and her neighbors. Although many countries in the

region openly oppose the current government of South Africa, they have extensive economic dealings with South Africa. Increased efforts have been underway to reduce these economic dependencies through new regional arrangements such as the SADCC (Southern African Development Coordinating Conference). This study examines the motivations, problems, costs, and benefits of new efforts to reduce the influence of South Africa on her neighbors and concludes with a discussion of future possible political scenarios.

American Disinformation vs. Libya

RESEARCHER: MIDSHIPMAN 2 C TRAVIS D. ZACH

ADVISER: ASSOCIATE PROFESSOR STEPHEN E. FRANTZICH

In October 1986 the United States was accused of engaging in a campaign of disinformation against the government of Libya. This project was a case study of the events following the public disclosure of the disinformation affair to determine the advantage of the use of disinformation for the United States. The initial hypothesis was that for the United States, the potential risks of using disinformation significantly outweigh the benefits of a successful disinformation attempt.

The method of research was a broad survey of governmental press releases and news media commentary (foreign and domestic), with a time frame roughly encompassing the month of October 1986 (the disinformation allegation was made in the *Washington Post* on 2 October). Domestic newspapers, *The Foreign Broadcast Information Service*, and the *Legi-Slate* computer net were the primary sources.

It was found that the Libyan disinformation affair (1) created intense media resentment and outrage, leading to increased media distrust of the government; (2) created conflict within the U.S. government among the executive, congress, the military, and the intelligence community; (3) gave Gadhafi numerous propaganda opportunities and enhanced his status and credibility versus the U.S.; and (4) gave the Soviet Union valuable propaganda resources on the eve of the U.S.-Soviet summit meeting at Reykjavik.

The hypothesis was supported by the case study of the Libyan affair. Assuming that the Libyan affair is representative of U.S. attempts to employ disinformation as a foreign policy tool, the damage to U.S. credibility supersedes any benefits had the campaign been a success.

Recent Trends in Soviet Propaganda Efforts in Western Europe

RESEARCHER: MIDSHIPMAN 2 C TRAVIS D. ZACH

ADVISER: ASSOCIATE PROFESSOR HELEN E. PURKITT

Since Mikhail Gorbachev became head of the Communist Party of the Soviet Union in March 1985, he has been well received by America's key allies in Western Europe. He has been hailed by many as a positive influence on world peace, somehow less threatening to Western European security than past Soviet leaders. The purpose of this project was to determine the main points of Soviet policies towards Western Europe and how they may have changed under Gorbachev's reign. The initial hypothesis was that Gorbachev's policies towards this region are not significantly less aggressive or negative from those of his predecessors, and they may have become even more negative from the West European perspective.

The study was treated as a pilot for possible further research. It was a longitudinal content analysis of Soviet news media commentary towards Great Britain, France, and the Federal Republic of Germany regarding arms control and disarmament. It

was assumed that Soviet media commentary is an accurate reflection of official government attitudes. The units of analysis were individual paragraphs from the Foreign Broadcast Information Service *Daily Report* on the Soviet Union. The time frame was roughly the first year of Gorbachev's reign (1 April 1985 through 31 March 1986). The scope was kept narrow so that the feasibility of more extensive research in this area could be determined.

The results of the study were mixed and complicated. The Soviet Union seems to view Western Europe as more militaristic and more prone to conflict than before Gorbachev. But Soviet reference to European realism also increased in frequency, while references characterizing Western Europe as aggressive decreased. Taken as a whole, the data seemed to suggest a slightly negative trend in Soviet attitudes, policies towards Western Europe. Further research is needed for more concrete conclusions.

Publications

ATKINS, G. Pope, Professor, "International Relations in the Southern Cone," *Latin American and Caribbean Contemporary Record*. New York: Holmes & Meier, 1986, pp. 66-77.

The Southern Cone of South America is the center of an international political subsystem with special characteristics. The states in the subregion have their own set of issues and patterns of interaction; they are part of or have links to the South Atlantic region and interests in the Antarctic; and the nature of their relations outside the hemisphere does not apply to the rest of Latin America. The course of recent international relations has been marked by an increased U.S. role because of the debt problem, but the presence continued of a broad array of other influential external states; considerable progress in the resolution of the Argentine-Chilean dispute in the Beagle channel; and continued evolution of Argentine-Brazilian rapprochement. On the other hand, there was little movement toward accommodation of contending Argentine and British positions over the Falkland/Malvinas Islands dispute, or toward establishing more cooperative bases for the 1991 Antarctic review. In addition, the reestablishment of constitutional democracy or its continuation in most local states had important international implications.

FRANTZICH, Stephen E., Associate Professor, *Storming Washington: An Intern's Guide to National Government*. Second Edition. Washington, DC: American Political Science Association, 1986.

A resource guide for students considering academic internships which outlines the process of acquiring an internship and making the most out of an internship experience. The emphasis is on improving the academic component of experiential learning.

FRANTZICH, Stephen E., Associate Professor, "The Implications of Congressional Computerization," *Bulletin of the American Society for Information Science* (February-March 1987): 7-10.

A discussion of how the adoption of modern in-

formation and communications technology has affected the social, organizational, and political aspects of the U.S. Congress.

HARFE, Barbara, Assistant Professor, "Empathy for Victims of Massive Human Rights Violations and Support for Government Intervention: A Comparative Study of American and Australian Attitudes," *Political Psychology* 8, 1 (1987): 1-20.

This study explores the extent of public concern in two Western societies for massive human rights violations elsewhere in the world, and public willingness to support international action on behalf of the victims. The survey samples consisted of 210 undergraduates at Northwestern University and 121 undergraduates at LaTrobe University (Melbourne). The technique used was to determine the extent to which emotional arousal, prompted by depictions of atrocities, translated into empathy for victims and support for remedial political action. The results demonstrated that almost all American and Australian students clearly recognize certain governmental actions as human rights violations, and most of them accept the validity of government intervention on behalf of human rights. The study also shows that most respondents were willing to make personal sacrifices in defense of other people's human rights.

HARFE, Barbara, Assistant Professor, "Genocide as State Terrorism," *Government Violence and Repression: An Agenda for Research* (eds. Michael Stohl and George A. Lopez, New York: Greenwood Press, 1986, pp. 165-188).

Genocide is distinguished from repression. Brief case studies are offered of genocides in Turkey (against Armenians), Burundi (against the Hutu), Kampuchea, and East Timor. Comparative analysis of the cases shows that all were preceded by major political upheavals and occurred in societies with a history of ethnically or religiously polarized conflict and, at the times of the episodes, a lack of constraints from the international environment. Guidelines for further comparative research are specified.

HARFE, Barbara, Assistant Professor, **"The Etiology of Genocides,"** *Genocide and the Modern Age: Etiology and Case Studies of Mass Death*, eds. Isidor Walliman and Michael N. Dobkowski. New York: Greenwood Press, 1987, pp. 41-60.

This chapter identifies a set of conditions which, in various combinations, are associated with the occurrence of genocides. The first is structural political change, a necessary but not sufficient condition. A second factor is the existence of sharp internal cleavages between contending groups. Third is the lack of external constraints on, or foreign support for genocidal regimes. Types of genocide are distinguished and contemporary examples identified: postwar and imperial genocides, postcolonial genocides, post-coup and post-revolutionary genocides, and genocides of conquest.

MATTOX, Gale A., Assistant Professor, **"The Dilemmas of Extended Nuclear Deterrence,"** *Moral Reasoning and Statecraft: Essays Presented to Kenneth Thompson*. Washington, DC: University Press of America, 1987, pp. 177-202.

The premise of European defense since World War II has been the U.S. nuclear guarantee. The guarantee has been assured by the U.S. commitment to the defense of Western Europe through a strategy of extended nuclear deterrence. In spite of persistent and repeated U.S. reassurance of its commitment, the balance of forces and the perception of the threat have not remained static. As the broad-range of factors that constitute the European perception of its security has changed, verbal when not concrete changes in the Western defense posture have been important. This has included changes in the doctrines to implement that strategy. But despite the dilemmas with which nuclear deterrence confronts officials, it has remained and remains today the basis of U.S. security, and, by extension, European security.

There is little expectation that this strategy will change dramatically in the next few years. Indeed, the historical past suggests that changes will be gradual and evolutionary. But it would be incorrect

to ignore the potential challenges to the current assumptions of nuclear deterrence. This chapter attempts to address two questions: What are the shorter-term prospects for the direction of U.S. defense policy and the security of Europe? What will be the longer-term consequences of the inevitable evolution of current premises of European security and the extended U.S. nuclear deterrent?

MATTOX, Gale A., Assistant Professor, **The German Media and U.S. Foreign and Defense Policy: The Strategic Defense Initiative,"** *Mutual Perceptions: The U.S. and German Mass Media*, ed. Lore Amlinger. Stuttgart: Akademischer Verlag, 1987, pp. 23-53.

The role of the media in molding German public attitudes toward the United States is substantial. This is even more true in German attitudes on U.S. foreign and defense policy. In this chapter, the sources of the German "Amerikabild" of U.S. foreign and defense policy generally are examined and a case study of the German reporting of the U.S. Strategic Defense Initiative from 1983-85 is presented. The chapter conclusions are based on a review of national newspapers, magazines, and major daily TV coverage.

PURKITT, Helen E., Associate Professor, co-author, **"Review of Experimental Small Group Research,"** *Political Behavior Annual*. Boulder, Colorado: Westview Press, 1986, pp. 71-101.

Political scientists have been interested in the study of small groups as a result of their concerns with decision making in small governmental bodies with the effects of groups on political processes. Much of the past research has used experimental design. This article reviews and integrates recent research on the role of group processes with earlier results. Research areas covered include recent work on group compositions, expert-novice differences, leadership and communication networks, group negotiations and choice rules, the role of interaction, cognition and information, and the function of group processes.

PURKITT, Helen E. Associate Professor, co-author, "The Role of Cognition in U.S. Foreign Policy Towards South Africa," *Political Psychology*, 7, 3 (1986), 507-532.

This study describes the cognitions or mental heuristic used by top officials of the Carter and Reagan administrations in articulating and justifying U.S. foreign policy toward Southern Africa during a 4-year period, 1979-1982. Content analysis and events data analysis were used to analyze how prior beliefs and attributions of top officials influenced public statements. Key findings included the results that foreign policy spokespersons focus on a few redundant dimensions in their articulations, that Reagan officials were more likely than Carter spokespersons to emphasize casual attributions and that cognitions translated into differences in behavior on overriding issues.

RACHWALD, Arthur R., Associate Professor, "Poland 1986," *Yearbook on International Communist Affairs*, ed. Richard F. Starr, Stanford, California: Hoover Institution, 1987, pp. 310-330.

This chapter examined internal and foreign policy developments in Poland in 1986. The primary purpose of this study was to analyze the emerging pattern of relationship between the ruling Communist party and its two principal rivals, the Roman Catholic Church and the outlawed independent trade union, Solidarity. The foreign policy part of this study focused on improvement of the Polish-American relations that resulted in lifting of the U.S. economic sanctions imposed in 1982 after suppression of Solidarity.

RACHWALD, Arthur R., Associate Professor, "Time to Mend Bridges with Poland," *Worcester Telegram*, 15 October 1986.

This article advocates lifting the American economic sanctions against Poland. Political and economic isolation of Poland from the United States facilitates Soviet control over the Polish nation, as well as reinforcing the feeling of resignation among the Poles. Active American involvement in Eastern Europe is necessary for preservation of semi-independent status of this region.



Presentations

ATKINS, G. Pope, Professor, "1986 Elections in the Dominican Republic," Seminar on the Dominican Republic, Georgetown University Center for Strategic and International Studies, Washington, DC, 23 June 1986.

COCHRAN, Charles L., Professor, "What Intelligence Policy Can Accomplish," Mount St. Mary's College, Emmitsburg, Maryland, 23 March 1987.

FRANTZICH, Stephen E., Associate Professor, "The National Parties and the Recruitment of Congressional Candidates," Southern Political Science Association Convention, Atlanta, Georgia, 6 November 1986.

FRANTZICH, Stephen E., Associate Professor, "C-SPAN in the Classroom," Benton Foundation Seminar, Washington, DC, 19 January 1987.

FRANTZICH, Stephen E., Associate Professor, "Technological Change and Representative Government," U.S. Congress, Office of Technology Assessment Panel Meeting, Washington, DC, 5 March 1987.

FRANTZICH, Stephen E., Associate Professor, "Public Access to Congressional Information: The Promise and Pitfalls of Technology-Enhanced Information," U.S. Congress, Office of Technology Assessment Panel Meeting, Washington, DC, 1 May 1987.

FRANTZICH, Stephen E., Associate Professor, "Computerizing Congress - Some Abiding Lessons," German Bundestag Study Group, Bonn, Germany, 18 May 1987.

HARFF, Barbara, Assistant Professor, "Modeling State Repression, National and International Factors," American Political Science Association Annual Meeting, Washington, DC, 29 August 1986.

HARFF, Barbara, Assistant Professor, co-author, "Toward Empirical Theory of Genocides and Politicides: Identification and Measurement of Cases since 1945," International Studies Association Annual Meeting, Washington, DC, 15 April 1987.

PURKITT, Helen E., Associate Professor, "How People Process Information in Making Political Decisions," Ninth Annual Meeting of the International Society of Political Psychology, Amsterdam, The Netherlands, 30 June 1986.

PURKITT, Helen E., Associate Professor, "Cognition, Leadership, and Federal Budget Deficits," Western Political Science Association, Anaheim, California, 20 March 1987.

PURKITT, Helen E., Associate Professor, "Experimentation and the Study of Political Decision Making: Results from an Information Processing Experiment," International Studies Association, Washington, DC, 16 April 1987.

MATTOX, Gale A., Assistant Professor, "Strategic Defense Initiative and the Allies," International Affairs Fellows Annual Conference, Council on Foreign Relations, New York, New York, 14 June 1986.

MATTOX, Gale A., Assistant Professor, "German Defense Policy," National War College Seminar Ft. McNair, Washington, DC, 19 October 1986.

MATTOX, Gale A., Assistant Professor, "The Atlantic Alliance in Crisis?" Annual Conference, Section on Military Studies, Harvard University, Boston, Massachusetts, 8 November 1986.

MATTOX, Gale A., Assistant Professor, Discus-sant, "German Views of Arms Control," American Institute for Contemporary German Studies, Washington, DC, 21 January 1987.

MATTOX, Gale A., Assistant Professor, "Selected Issues in NATO," National Security Seminar, Naval Air Command Systems, Fredericksburg, Virginia, 4 February 1987.

MATTOX, Gale A., Assistant Professor, "Arms Control and European Security," Annual Conference, International Studies Association, Washington, DC, 17 April 1987.

MATTOX, Gale A., Assistant Professor, "Workshop on U.S.-German Foreign Policy-Making," Foreign Service Institute, Rosslyn, Virginia, 14 May 1987.

RACHWALD, Arthur R., Associate Professor, "Party vs. Church in Poland," Stanford University-Hoover Institute, Stanford, California, 1 July 1986.

RACHWALD, Arthur R., Associate Professor, "Soviet Union-Western Europe," Maryland Retired Officers Association, Kent Island, Maryland, 16 April 1987.



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